FINAL Interagency RFI Response

In Support of the

Manna Fish Farms Gulf of Mexico Project

Manna Fish Farms, Inc.

Action Proponent

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1. Executive Summary

Manna Fish Farms, Inc. (MFF) and The University of Southern Mississippi entered into a memorandum of agreement in August 2018 to collect data, gather information, and complete the procedures to apply for permits to operate a finfish farm in the Gulf of Mexico. Funding for this work has been a mix of private funds and federal grants. The grant support has allowed for a transparent and open process that considers outreach to stakeholders as well as communications with federal and state agencies to determine where regulatory gaps may exist, or where techniques, methods, and materials may be better informed.

Grant funding has been provided by the National Oceanic and Atmospheric Administration (NOAA) through the Gulf States Marine Fisheries Commission Aquaculture Pilot Projects. Team members for this work include: Manna Fish Farms, Inc., StormSafe® Submersible Net Pens, the Thad Cochran Marine Aquaculture Center and Hydrographic Science Research Center at the University of Southern Mississippi, Mississippi-Alabama Sea Grant Legal Program and National Sea Grant Law Center at the University of Mississippi, New Hampshire Sea Grant and The University of New Hampshire (together, MFF project team). Scientific support was provided by the Coastal Aquaculture Siting and Sustainability program (CASS), NOAA National Centers for Coastal Ocean Service (NCCOS). Archaeological support for the first baseline environmental survey (BES) was completed by P & C Scientific, and David Evans and Associates, Inc. executed the second baseline environmental survey, and provided geological and archaeological analysis.

1.1. Siting Analysis and Pre-Application Meeting

Pre-site screening for the Manna Fish Farms, Gulf of Mexico farm operations commenced in August 2018. Site selection followed the guidance of the pre-application checklist outlined by the National Oceanic and Atmospheric Administration (NOAA), Southeast Fisheries Regional Office as part of the Gulf of Mexico Aquaculture Fishery Management Plan. The pre-screening process used publicly-sourced information and farm operation specifications to select areas of interest, and the scientific support resources of the Coastal Aquaculture Siting and Sustainability program (CASS), NOAA National Centers for Coastal Ocean Service (NCCOS).

The CASS team used the data provided and a site suitability model that considered multiple data layers including but not limited to: bathymetry, military zones, shipping lanes, vessel traffic, shrimp vessel activity, artificial reefs, submarine cables, oil and gas platforms, oil and gas wells, oil and gas leases, oil and gas pipelines, lightering zones, corals, shipwrecks, critical habitats, and essential fish habitats to define areas that range from more compatible for aquaculture operations to areas that are less compatible. These suitability maps helped narrow site selection to five potential locations for siting the farm. The pre-application checklist contained information on all five locations including maps, data layers considered, and the preferred location. Also included in the application was the proposed annual production plan, feed-type, feed usage, the draft layout of the farm, information about the net pen design and mooring, construction timeline, and vessel usage.

A conference call initiated by the NOAA Southeast Region Aquaculture Coordinator introduced the project to the Interagency Aquaculture Working Group on November 6, 2018. Following the call, the pre-application checklist was submitted to the Interagency Working Group **(Appendix A)**. A formal presentation of the pre-application was provided as part of the pre-application meeting on December 12, 2018. Agencies that participated in the pre-application meeting included the Environmental Protection Agency (EPA), NOAA, Bureau of Ocean and Energy Management (BOEM), Bureau of Safety and Environmental Enforcement (BSEE), U.S. Fish and Wildlife Service (FWS), U.S. Army Corps of Engineers (USACE), U.S. Coast Guard (USCG), U.S. Navy, U.S. Air Force, Department of Defense (DOD), and U.S. Department of Agriculture (USDA).

The preferred site location is located in a military zone, therefore a request was made to the Department of Defense (DOD) Military Aviation and Installation Assurance Clearinghouse to operate within the boundaries of the military zone. Representatives from NCCOS-CASS communicated with the DOD for clearance of the site. The DOD responded by letter in February 2019 indicating the aquaculture farm should not present any issues operating in the military zone, and requested that the MFF project team be in touch with the Navy regarding monitoring equipment on the farm **(Appendix B)**.

1.2. Data Collection and Analysis

The first baseline environmental survey plan followed the NOAA guidance associated with Gulf of Mexico Aquaculture Fishery Management Plan, with any modifications discussed with the EPA, NOAA, and USACE. An archaeologist participated in the survey planning and contacted the Florida State Historical Preservation Office to discuss specifications it may have for the survey. A presentation outlining equipment, specifications, and survey collection procedure was prepared and presented to EPA, NOAA, and USACE in March 2019 **(Appendix C)**. The survey plan was emailed to the EPA, NOAA, USACE, Florida Department of Agriculture, and Florida State Historical Preservation Office for any additional agency guidance, changes, or clarifications prior to commencing the survey.

After receiving comments from agencies indicating the survey plan would produce adequate coverage for the assessment, the team initiated the 700-acre area survey. Multibeam echosounder, side-scan sonar, magnetometer, and subbottom profiler data were collected and assessed for the report. An Acoustic Doppler Current Profiler (ADCP) was deployed in August 2019 to collect current data near the site. The first baseline environmental survey report can be found in **Appendix D** and the ADCP processing report can be found in **Appendix E.**

Following a review of the draft BES report in July 2019, the EPA expressed concern about the consolidated substrate (hard-bottom) ridge detected between the 54 and 56 meter depth contours. The EPA informed the MFF project team that the point of discharge for the net pens would need to be 1000 meters away from this, or any other, hard-bottom. The EPA also asked the MFF project team to contact the nearby artificial reef managers with regard to potential offsetting from the reef boundary. The nearest artificial reef located to the west of the survey site is managed by Escambia County, FL. County officials informed the MFF project team by email that 500 feet from the boundary of the reef permit area to the boundary of the finfish farm permit would be adequate **(Appendix F).**

In July 2019, NOAA National Marine Fisheries Service (NMFS) Southeast Regional Office (SERO) produced an updated map of the Gulf of Mexico Bryde's whale core distribution area. The Gulf of Mexico Bryde's whale has since been identified as a new species: the Rice's whale.

To accommodate the 1000-meter distance from the detected consolidated substrate ridge and the 152.4-meter (500 ft) distance from the boundary of the artificial reef, the team worked with NCCOS-CASS to relocate the potential farm site to the north of the ridge but in water depths adequate for the preferred net pens. Of particular interest was the MFF project team's desire to move to the north to locate further from known Gulf of Mexico Bryde's whale (now Rice's whale) sightings. The new farm sites included areas that were not covered by the first BES area, and a new survey was planned.

The second BES plan also followed the NOAA guidance associated with the Gulf of Mexico Aquaculture Fishery Management Plan, with any modifications discussed with the EPA, USACE and NOAA. An archaeologist participated in the survey planning. The potential farm layouts included three different farm configurations. Consideration of the EPA's 1000-meter from any hard-bottom requirement more than doubled the area to be surveyed. In consultation with the EPA, USACE, and NOAA, the MFF project team discussed potential modifications of requirements for the second survey, and additional permit information for nearby areas. Modifications to this survey included limiting the collection of multibeam data to the potential farm sites, and not surveying in the adjacent Large Area Artificial Reef Site (LAARS) managed by Escambia County. These modifications allowed the required information to be collected and reduced cost.

The MFF project team had discussions with the EPA, USACE, and NOAA regarding the permit requirements of the LAARS Artificial Reef area managed by Escambia County. This artificial reef area is actively managed by Escambia County in accordance with state and federal permits. Their strategic management plan accounts for all aspects of reef material placement and post-deployment monitoring, and requires that seafloor characteristics are clear of natural reefs and archaeological resources prior to deployment (Turpin, 2009). The closest artificial reef to the fish farm boundary, deployed in 1994, is composed of concrete and is located approximately 3.1 km to the west. Just west of those concrete pyramids is a metal Chevron platform that was deployed in 1993. The Oriskany Memorial Reef is an 888 ft aircraft carrier that was deployed in 2006 and is located approximately 3.8 km south of the fish farm. An ecological assessment was performed prior to the sinking of this vessel that accounted for environmental, geological, and archaeological resources near the deployment area (Johnston et. al, 2006**).** Additionally, Florida Fish and Wildlife Research Institute (FWRI) conducts research that includes side-scan sonar and drop cameras to characterize potential reef fish habitat. The current coverage area for these surveys nearby the preferred farm location can be seen in **Appendix G**, and the side-scan and habitat assessment can be obtained through FWRI. Based on permit requirements and the active management and monitoring of the artificial reef area, it was determined that additional data collection in the reef area was not necessary.

In October 2019, a second baseline environmental survey plan was presented and emailed to EPA, NOAA, and USACE for any additional agency guidance, changes, or clarifications prior to commencing the second survey. Due to scheduling conflicts the second survey was unable to be completed in the late fall and winter. The MFF project team elected to contract with a private firm to complete the second survey in early 2020, however, the COVID-19 pandemic created additional scheduling and procurement challenges. The second survey was rescheduled and completed in December 2020. Processing was complete in early 2021, and a draft copy and presentation of results was provided to the EPA, USACE, and NOAA in March 2021. The second BES report can be found in **Appendix H.**

The multibeam data collected in the second BES was primarily used by the MFF project team for precision siting of the net pens and anchors. The limiting of multibeam data collection to the potential farm sites did not compromise information needed by the archaeologists, geologists, biologists, or engineers to assess the entire 1400-acre survey area for archaeological and/or cultural resources, or geophysical characteristics. The side-scan sonar, magnetometer, and subbottom profiler data was collected over the entire 1400-acre survey area, and provided sufficient information for the aforementioned assessments.

Data collected in the second BES and by the ADCP and other sensors in the region were used to support an engineering analysis of the net pen structure and its associated mooring system **(Appendix I)**.

1.3. Outreach

Outreach activities for the project can be divided into pre-site selection activities and post-site selection activities. The tools and activities were designed to facilitate meaningful engagement and feedback in the early stages of the planning. Tools for outreach included phone calls, a website, social media advertising, presentations, displays, surveys, and feedback forms.

During the pre-site selection, the team worked to engage regulators, commercial and recreational fisherman, and members of environmental organizations via calls and meetings. The goal during this stage was to provide general information about the project and solicit feedback on things to consider for siting the farm. Feedback helped the team narrow down considerations for siting the farm such as commercial shrimping activity, vessel traffic, and landing requirements. Additional comments such as providing access to fishing around the net pens and suggestions for monitoring activities also were received.

Once the site was selected, the team narrowed the focus of outreach to information on the siting analysis, regulatory process, operational information, and biological and environmental information. The team engaged specific regulatory agency divisions/offices, individuals, and organizations, in contrast to the previous broad regional calls. The team produced a website (http://masglp.olemiss.edu/gulftimeline/index.html) that supplies basic information, timeline, and links to additional information on the best available science for siting the farm.

Public presentations included conferences, formal public meetings, a stakeholder engagement event, and a workshop.

2019:

- A poster presentation was provided at the Atlantic and Gulf Seafood Technology Conference in Boston, MA on March 16, 2019. The audience was a mix of academics, seafood processors, dealers, wholesalers, federal and state agencies, and marketing representatives.
- A public presentation was provided at the Gulf of Mexico Fishery Management Council meeting on June 3, 2019 in Sandestin, FL. The presentation is part of the public record of that meeting, and the audience included Council members and both in-person and virtual audiences.
- A stakeholder engagement event following the Gulf Council presentation allowed for members of the audience and additional guests to engage with team members and ask questions. The stakeholder engagement event had a brief presentation outlining the project and introducing the team. Four stations with poster displays and a team member to address questions were provided. The station topics included: 1) project overview, 2) siting analysis, 3) net pen systems and operations information, and 4) biological and environmental information. A stakeholder engagement survey also was offered to those in attendance. The survey provided a mechanism for the team to follow up with those who requested additional information. The audience was comprised of people attending the Gulf Council meeting including commercial and recreational anglers, management agencies, academics, and non-governmental representatives.
- A presentation was given at the Pioneering Offshore Aquaculture Workshop sponsored by Florida Sea Grant on June 27, 2019 in Sarasota, FL. The audience was a mix of regulators, anglers, commercial fisherman, non-governmental entities, and academics.
- A presentation was provided to the Aquaculture Subcommittee of the National Science and Technology Council (NSTC) for the White House Office of Science and Technology Policy in November 2019. The presentation highlighted the Manna Fish Farm project, current challenges, and potential solutions.

2020:

- A presentation titled *Navigating Regulatory Processes in Marine Aquaculture* was provided in February 2020 at Aquaculture America in Honolulu, HI. The audience was a mix of academics, federal, and state agencies.
- A presentation on the Gulf of Mexico Manna Fish Farms project was provided to the Regional Sea Grant Aquaculture and Seafood meetings in August 2020. This

consisted of four virtual meetings: 1) NE/Mid-Atlantic, 2) SE/Gulf, 3) Great Lakes, and 4) West Coast. The audience was Sea Grant employees engaged in seafood and aquaculture.

2021:

- A public presentation at the Gulf of Mexico Fishery Management Council meeting was provided on June 23, 2021 in Key West, Florida. The presentation is part of the public record and included Council members and both an in-person and virtual audience.

2. Engineering Information

Manna Fish Farms intends to deploy a series of StormSafe® Submersible Net Pens at the specified site approximately 23 nautical miles southeast of Pensacola, FL in water depths ranging from 45-50 meters. MFF will follow a four-phased deployment approach during the 5-year EPA NPDES permit period, starting with the deployment of two net pens the first year and resulting in a total of 12 net pens deployed over time. These net pens will be stocked with juvenile Red Drum (*Sciaenops ocellatus*) produced at a land-based hatchery, and used for the "growout" period of these fish. In the early phases of the project when fewer nets pens are deployed, the fish will be fed manually by trained staff. During this time, all offshore operations will be supported by a support vessel(s) that will remain moored on-site for the majority of the time, with known exceptions such as storm events and re-supplies. Once production reaches Phase 3, automated feed barges will be permanently deployed to supplement the support vessels and serve as the "headquarters" of the operation. There will be two feed barges on-site at full deployment. These barges will remain on-site 24/7 (using the same moorings the support vessels did) to store and deliver feed and support day-to-day operations. The purpose of the support vessels will then transition to resupplying the barges with feed and supporting all stocking and harvest procedures.

The net pens and the feed barges will be moored to the seafloor using gear that is standard in the offshore industry. Each net pen will be moored individually, using a 6-line catenary mooring system to remain in the intended farm location. This mooring system was specifically designed for use in conjunction with the StormSafe® net pen at this specific offshore site. This optimized design was a result of the hydrodynamic numerical modeling that was performed in preparation for this project. This modeling effort focused on a motion and loading analysis for the StormSafe® net pen with the aforementioned mooring system, subjecting the design to both 50 and 100-year storm conditions that may occur at the site. The details of this modeling and the subsequent engineering report can be found in **Appendix I**. The shared moorings for the support vessel(s) and feed barge(s) will use of a similar catenary leg design.

2.1. Farm Layout

The optimized mooring design for the StormSafe® net pens has a mooring scope of approximately 1.2:1, resulting in a horizontal distance of 60 m between an anchor and its respective surface spar buoy when deployed in a water depth of 50 m. This translates to a maximum horizontal footprint of 180 m for each individual net pen system. The positioning of all 12 net pens considers key design criteria such as water depth, minimum allowable distances between gear, required setback distances, and sediment properties within the surveyed area. The resulting layout includes a minimum distance of 50 m between all drag embedment anchors (both net pen and support vessel / feed barge). All net pens are located a minimum distance of 178 m apart. These minimum distances exist to provide adequate spacing between gear for operational and storm-event purposes, and to mitigate any potential marine mammal interactions. The feed barges, deployed in Phases 3 and 4, will be strategically located within the 12-net-pen array. The intended farm layout is visualized in the plan and profile view drawings found in **Appendix J**.

2.2. Proposed Gear

The following section details all of the individual net pen and mooring components for the MFF project, including their specifications and ideal properties. Manufacturer information is available separately in the confidential business information (CBI) document. A table of the primary gear and their specifications can also be found in **Appendix J**.

2.2.1. StormSafe® Submersible Net Pen

The StormSafe® Submersible Net Pen is a hexagonal net pen designed with six vertical, air-filled spars. Each spar houses three separate buoyancy chambers, with a network of air hoses connecting them to a manifold. These integrated air hoses and buoyancy chambers enable StormSafe® to be safely lowered to any depth in less than two minutes. The (18) isolated air chambers make the net pen exceptionally safe and easy to raise or lower in the water, with built-in redundancy to allow virtually no chance of sinking to the bottom. This quick submersibility allows workers to lower the net pen out of harm's way during adverse conditions, and eliminates the possibility of operator error. The net pen is raised simply by supplying air to the buoyancy chambers with a small air compressor. Enough air can be added to the spars to raise the 15-meter-tall structure as much as halfway out of the water for cleaning of the nets, towing, and maintenance.

StormSafe®'s unique, vertical spar design makes it inherently stable in rough, high-wave conditions. Marine net pens are typically framed with horizontally floating tubes that are dangerously susceptible to water movement, twisting, and bending. StormSafe® has been tested in the open waters of Lake Huron with results showing very minimal vertical movement, even in waves two meters and higher. The lack of net pen motion in these conditions translates to less fatigue on the hinges and connection joints, which in turn significantly extends the life of the structure. The vertical spars and overall stability also mean the system experiences far less water resistance than typical net pens, minimizing drag forces induced by waves and currents that pass through.

The StormSafe® net pen also addresses the possibility of waterborne contaminants (i.e. harmful agal blooms, oil spills, etc.) that could be devastating to fish health. Robust tarps can be deployed to protect the stock from contaminants while also enabling clean, oxygenated water to be upwelled from deeper, uncontaminated waters. The tarps roll down the inside of the net and can be deployed rapidly.

The StormSafe® net pen structural materials and net mesh materials are listed below, and the engineering designs of the StormSafe® net pen can be found in Appendix B of the CBI document.

- StormSafe® Net Pen Materials
  - All aluminum structural members are 6061-T6
  - All steel structural members are 44W
  - All components will be hot-dip galvanized to prevent corrosion

- Net Mesh Materials
  - All net mesh will be representative of the best product available at the time of installation, but is expected be an industry-proven polyethylene material.
  - MFF will utilize a multi-net system to account for predation: using a predator net not to exceed 3.5” stretch (with either size #36 or #42 twine braided or twisted) on the exterior, and a smaller primary net (i.e. 2” stretch) on the interior to contain the fish.

- Contaminant Prevention Tarps
  - These tarps are either a polyethylene or ripstop nylon-type mesh that are sufficiently water-resistant to obstruct the majority of waterborne contaminants from passing through. The tarps’ inherent resistance to water flowing through them promotes the desired upwelling effect.

2.2.2. StormSafe® 6-line Mooring System

Manna Fish Farms will use the StormSafe® Submersible Net Pen for all phases of deployment, and each net pen will utilize the optimized 6-line mooring design mentioned above in Sections 2 and 2.1. This system consists of a catenary-type mooring leg connected to each of the vertices of the hexagonal StormSafe® net pen, resulting in a total of six mooring legs per net pen system. Each mooring leg will include a surface spar buoy that tensions the system and provides adequate buoyancy to support the net pens when they are submerged. The mooring lines will attach to the bottom of the spar buoys, and the buoys will be attached to the net pen’s corners via bridle lines. All components of the intended mooring system are detailed below in seafloor to surface order, and are visualized in the profile-view mooring leg drawing found in **Appendix J**. *MFF will adhere to the component structural requirements listed below and in **Appendix I**,* *however, the exact products used to satisfy these requirements are subject to change as technology advances over time. The products listed below reflect what is currently commercially available at the time this document was created.*

Anchor

Each individual net pen system will be moored to the seafloor using a total of six high efficiency, modern drag embedment anchors. The selected anchors are known for their minimal drag distance prior to penetration, minimal soil disturbance, and significant holding power to weight ratio. Each of these anchors has an approximate footprint of 5.96 m^2 (64.15 ft^2), however, they will be fully embedded in the seafloor (assuming the maximum design load is not reached prior to full embedment during installation). The anchor to be deployed has a weight of 3000 kg and a subsequent estimated holding power of 222 MT in sandy sediments. This anchor exceeds our required anchor holding capacity of 202 MT. The anchors will be 3000 kg high efficiency drag embedment anchors.

Anchor Shackle

Each anchor will be connected to its respective anchor chain using a 50.8 mm (2”) anchor shackle. These shackles will be made of steel and contain a double-nut pin termination. This specific shackle size has a minimum breaking load (MBL) of 227 MT, which exceeds our required MBL of 202 MT. The anchor shackles will be 50.8 mm (2”) shackles made of galvanized steel.

Anchor Chain

Each mooring leg will feature a shot (27.4 m) of anchor chain to unify the anchor with the fiber rope anchor line, and minimize vertical loading applied to the anchor. The entirety of this chain, 27.4 m (90 ft), will be in contact with the seafloor for each mooring leg in the design configuration. A small portion of the chain will be embedded in the seafloor along with the anchor. The chain selected for this use is 48 mm (1.9”) Grade 3 studless chain. This specific anchor chain has a MBL of 184 MT, which exceeds our required anchor chain MBL of 175 MT. The anchor chains will be 48 mm (1.9”) diameter, Grade 3 studless chain, made of galvanized steel.

Anchor Line

The fiber rope selected for this mooring system is a high strength, shock absorbent, and elastic product, as was recommended by the hydrodynamic engineering analysis. The product material is nylon. Nylon ropes, commonly used in permanent offshore moorings, are known for their excellent abrasion resistance, shock absorption properties, and elasticity. The intended fiber rope has a diameter of 88 mm (3.5”). This specific diameter nylon rope has a spliced, wet MBL of 217 MT, which exceeds our required MBL of 191 MT. The anchor lines will be 58.3 m long, 88 mm (3.5”) diameter nylon rope. The “calm-water” tension (no waves, no current) of the anchor lines when the net pens are submerged is expected to be approximately 4533 N (1024 lbs). The tension of the anchor lines during average site conditions (0.9 m significant wave height, 0.21 m/s current velocity) when the net pens are submerged is expected to be approximately 35,875 N (8045 lbs). The selected nylon anchor lines do not tend to “loop” when these tensions are applied, and the large diameter of this line provides increased visibility and minimized likelihood of entanglement. The excellent abrasion resistance of nylon negates the need for sheathing of these lines.

Connecting Links

All mooring and bridle line connections will consist of a 50.8 mm (2”) anchor shackle. These shackles will be made of steel and contain a double-nut pin termination. This specific shackle size has an MBL of 227 MT, which exceeds our required MBL of 202 MT. All connection links will be 50.8 mm (2”) anchor shackles made of galvanized steel.

Surface Spar Buoy

The surface buoys selected for this mooring system will feature a spar-shaped design, extending below the surface of the water to mitigate potential component fatigue caused by oscillatory motion of the buoy in response to high frequency wave action. These spar buoys will be cylindrical in shape, with an aspect ratio of 5:1. The bottom of the spars will feature a steel padeye, which will serve as the connection point for the mooring leg. An additional padeye will be mounted on the lower half of the spar on the vertical face, and will serve as the connection point for the bridle lines. Both padeyes on the spar buoy will feature a MBL of approximately 420 MT. The buoys will have a net buoyancy of 5000 kg, which matches our required surface buoy net buoyancy of 5000 kg. The surface spar buoys will be 5.8 m tall with a diameter of 1.2 m, made of steel, and filled with foam.

Bridle Line

The bridle lines that unify the net pens and their respective surface spar buoys have similar structural requirements to the anchor lines. The same fiber rope product used for the anchor lines will also be used for the bridle lines, as all requirements for the bridle lines are satisfied by this product. This nylon rope has a spliced, wet MBL of 217 MT, which exceeds our required MBL of 191 MT. The bridle lines will be 14.9 m long, 88 mm (3.5”) diameter nylon rope. The “calm-water” tension (no waves, no current) of the bridle lines when the net pens are submerged is 4116 N (925 lbs). The tension of the bridle lines during average site conditions (0.9 m significant wave height, 0.21 m/s current velocity) when the net pens are submerged is expected to be approximately 49,725 N (11,151 lbs). The selected nylon bridle lines do not tend to “loop” when these tensions are applied, and the large diameter of this line provides increased visibility and minimized likelihood of entanglement. The excellent abrasion resistance of nylon negates the need for sheathing of these lines.

StormSafe® Submersible Net Pen

The StormSafe® net pen is a 15.2-meter-tall hexagonal prism with a 31.4 m diameter. These dimensions result in a total, useable volume of approximately 9000 m^3.

2.2.3. Support Vessel / Feed Barge Mooring System

The two support vessel / feed barge mooring systems shown in the farm layout drawing of **Appendix J** will each consist of eight catenary mooring lines. Each line will utilize a drag embedment anchor, of similar type to those used for the net pens, with the lines being either chain or a combination of chain and fiber rope leading up to the vessel / barge. The design specifications for these mooring line components will be based upon the mooring criteria of the feed barges, as the barges are expected to be more massive than the support vessels, and therefore have greater structural requirements. Each mooring line is expected to employ a 7:1 scope, which is typical for offshore vessel moorings. These two mooring systems are strategically located within the farm footprint to accommodate the engineering and operational requirements of the project. Each of these 16 drag embedment anchors will feature a crown line leading up to a small surface buoy to denote the location of the anchors. The exact specifications of the support vessel / feed barge mooring system will be subject to input from the feed barge manufacturer, and based on the results of their product-specific hydrodynamic analyses. MFF performed preliminary calculations with a hydrostatic analysis, based on a commercially available feed barge product, to yield estimates of the minimum allowable capacities and required component specifications seen below. This hydrostatic analysis of a single catenary mooring leg considered site-specific 10-year storm conditions (estimated in **Appendix I**) applied to a barge with the dimensions listed in Section 3.6.4. Safety factors and other design criteria used in this analysis were based on recommendations from the American Bureau of Shipping (ABS) and the American Petroleum Institute (API) for offshore structures. These design standards are listed in Section 7 of **Appendix I.** This analysis considered the 10-year storm to be the design maximum, as MFF's standard operating procedure will dictate the temporary removal of the feed barge from the site if a storm of equal or greater magnitude is forecast for the area. The details of this temporary removal will be outlined in MFF's Emergency Response Plan.

Anchor

Each support vessel / feed barge will be moored to the seafloor using a total of eight high efficiency, modern drag embedment anchors. The anchors to be deployed are expected to have a weight of 750 kg and a subsequent estimated holding power of approximately 74 MT in sandy sediments. This anchor exceeds the estimated minimum anchor holding capacity of 66 MT. Each of these anchors has an approximate footprint of 2.25 m^2 (24.22 ft^2), however, they will be fully embedded in the seafloor (assuming the max design load isn't reached prior to full embedment during installation).

Anchor Line

Each of the 16 catenary mooring legs will be either chain or a combination of chain and fiber rope. Assuming the line is entirely chain, the chain is expected to be a 32 mm (1.26") diameter, Grade 3 studless galvanized steel chain with a MBL of 85 MT. This chain would be 354.3 m in length, with approximately 245.0 m in contact with the seafloor for each mooring leg in the design configuration. This chain product exceeds the estimated minimum breaking load of 74 MT. The minimum tension of this anchor chain would be approximately 29.3 kN (6575 lbs) during average site conditions.

Crown Line

Each of the support vessel / feed barge anchors will feature a crown line attached to a small surface buoy to denote the anchor's location. Assuming the crown line is entirely chain, it is expected be an 18 mm (0.71") diameter Grade 2 studless galvanized steel chain with a MBL of 19.4 MT. The tension in this line would be approximately 2.8 kN (626 lbs) at the site's average depth of 50 m.

Crown Line Buoy

Each crown line buoy is expected to be either a steel or poly material, with a small diameter on the order of 1.02 m (40"). Assuming the buoy is steel, a buoy of this size would have a net buoyancy of approximately 4.4 kN (987 lbs).

2.2.4. Instrumentation

MFF will implement various types of instrumentation and sensors around the farm to collect data critical to maintaining and improving the operation throughout the course of the project. Underwater cameras and/or remotely operated vehicles (ROVs) will be deployed within each of the net pens to monitor fish health and behavior. Each net pen will have a GPS unit to provide real-time knowledge of the pen's location in the unlikely event that it breaks free from its mooring during a storm. In addition, several of the net pen's mooring and bridle lines (likely two of each) will be outfitted with submersible load cells during the first phase of the project. These load cells will aid in the quantification of hydrodynamic forces that the systems experience due to the site's environmental conditions. The load cells will be installed on lines that correspond to the direction that the dominant wave and current forces come <u>from</u> (i.e. load cells on the southernmost lines if the largest waves and currents come from the south). Locating the load cells on these lines allows for the measurement of the maximum forces that the mooring components are expected to experience. The data from these load cells will be analyzed and compared to the predictions of the hydrodynamic analysis in **Appendix I**. These comparisons will then help inform decisions for subsequent phases of the project. The forces recorded by the load cells will be correlated to environmental conditions by an instrumentation package located on-site that will collect relevant hydrologic data such as current and wave magnitudes and directions. This package will also include sensors to collect various water quality data required for the environmental monitoring process.

3. Supplemental Information

3.1. Feed Characteristics

The MFF project team is actively engaged in conversations with several major feed companies to determine the product and supplier that is the best fit for the project. Feed composition is evolving rapidly, and the best currently available product may not be the best product available when the project begins. More specific feed information will be supplied in future documentation. However, the chosen feeds are expected to have the following general characteristics. Feed used for the land-based juveniles will be slow-sinking with small pellet sizes. These small fish will be fed frequently throughout the day, while the larger, offshore fish will be fed a larger, slow-sinking pellet feed only twice per day. Feeding frequency will fluctuate according to the size of the cohort being fed, as will the feed conversion ratio (FCR). MFF anticipates FCRs to range from 1.0-1.5. The chosen feeds for the offshore fish will contain 42-52% protein and 12-18% fat, and the ratio of protein to fat will vary with the size of fish being fed as well. The selected feeds will not exceed 52% protein and 18% fat, as MFF expects the ideal protein and fat percentages for ocean-cultured Red Drum to be on the lower end of the listed ranges. The MFF project team has consulted with several feed manufacturers in an effort to identify suitable products. Among those feed manufacturers, Skretting identified three of their product lines as being suitable for this operation. The characteristics of those feed products are seen below in **Table 1**. Skretting also provided values for dry matter digestibility and nitrogen and phosphorous concentrations for two of those products, also seen in the table below. Additionally, independent research conducted by the MFF project team yielded a valuable reference for dry matter digestibility among warmwater fish species that supports the value reported by Skretting. Zhou et. al found that juvenile cobia (*Rachycentron canadum*), another euryhaline fish native to the GOM, achieved a dry matter digestibility of approximately 87.5% when fed a fishmeal-based diet (Zhou et. al, 2004).

***Table 1**: Feed products identified by Skretting as suitable for MFF GOM operation.*

Feed Product	Protein % (min)	Oil % (min)	Moisture % (max)	Ash % (max)	Fiber %(max)	Dry Matter Digestibility %	Nitrogen %	Phosphorus %
Nova GR	45	15	9.0	12.0	3.0	-	-	-
Nova RD	42	15	-	-	-	91.5	7.3	1.3
Marine MX	46	12	9.0	12.0	1.5	91.5	8.0	1.0

3.2. Feeding and Feed Distribution Methods

Feeding and feed distribution methods will vary depending on the phase of the project, the size of the fish, and the water temperature. In the early phases of the project before any permanent feed barges are deployed, the fish will be fed by hand and/or with a water-blown feed machine, by trained staff members using the farm's tender vessel(s). The fish will be fed every day, weather permitting. Once feed barges are deployed, the feed process will become automated, and the feed will be water-blown through feed hoses from the feed barge directly into the net pens. The on-site feed barges will enable feeding of the fish every day, regardless of inclement weather, and will improve both the economics and sustainability of the farm. Feed loss is anticipated to be less than 1% at all stages of production. This will be achieved through constant observation via a combination of underwater cameras and experienced staff members. The feed systems onboard the feed barges will be equipped with industry-standard sensors and software that will work in conjunction with the underwater net pen cameras to control all aspects of the feeding process. The automated feed systems enable precision feeding, with the ability to accurately control both quantity and delivery rate for each net pen. The behavior of the fish during feeding will always be monitored by both staff members and trained cameras specifically designed for such applications. MFF plans to use cameras that focus on both the fish and the feed to estimate consumption rates, allowing for the optimal minimization of feed loss. These cameras also enable real-time underwater observation that will assist staff members in observing behaviors indicative of satiation. Once the fish exhibit these behaviors, feeding will cease to minimize feed waste. The combination of underwater cameras and trained staff members serves as a fail-safe mechanism for the feeding process.

3.3. Fish Production Information

3.3.1. Stocking Method

The StormSafe® net pens will be stocked with juvenile fish, or fingerlings, once they grow to a pre-determined size at The University of Southern Mississippi's Thad Cochran Marine Aquaculture Center, a land-based hatchery facility in Ocean Springs, MS. Once a cohort of fingerlings reaches an appropriate stocking size, they will be transported via truck to the Port of Pensacola staging facility in insulated containers following the standardized protocols for hauling live fish found in Section 5.6.2 of the Fish Health Management Plan in **Appendix K**. The fish will then be loaded onto a farm vessel using an appropriately sized crane onboard the support vessel or at the port facility. This method keeps the juvenile fish in water throughout the process reducing stress, acclimation, and recovery periods and, ultimately, stress / transfer associated mortality. The support vessel and live hauling containers will be outfitted with systems adapted to ensure the safety and wellbeing of the fish during transport to the farm site. The systems will include portable water pumps to perform acclimatizing water exchanges at the site prior to release into the net pens, and oxygen delivery manifolds to maintain water quality. The fish will be moved from the vessel to the net pen using an FDA approved, reinforced PVC discharge hose relying on gravity to move the fish in the least stressful way possible. One end of the discharge hose will be attached to the hauling containers onboard the support vessel, and the other end will be inserted into the receiving net pen. Once the hose is secured in place, the internal discharge port gate within the hauling container will be opened, and the fish will be gravity-discharged directly into the net pen. This process is further detailed in Section 5.6.2 of the Fish Health Management Plan. The fish will be moved once they have fully acclimated to the water and after qualified staff verify the fish are recovering from any stress induced from the processes leading up to this final step. The hauling bin and discharge hose will be flushed several times to confirm there are no fish remaining in the transfer equipment; ensuring that the collection of this equipment back on the boat will not lead to any accidental discharges of fish outside the net pens. All precautions will be made to minimize the stress on the fish during the transfer and stocking procedures.

3.3.2. Tiered Production

MFF will use a tiered production approach to achieve harvest and subsequent sale of fish for as many months out of the year as possible. The number of months during which harvest occurs will increase over the course of the project as additional net pens are deployed and stocked with fish. The goal will be for each of the 12 net pens to contain a different size cohort. Once the net pen with the largest cohort of fish reaches harvest size, that net pen will be gradually harvested over the course of 2-4 weeks. While that net pen is being harvested, the net pen with the second largest cohort of fish will reach harvest size. Harvest of the second cohort will begin once harvest of the first is completed, and this cycle will theoretically continue year-round. Once each net pen is fully harvested, it will be left empty to allow for fallowing for 2-4 weeks. During the fallowing period (in suitable weather conditions), the empty net pen will be raised above the typical surface configuration water level such that increased net mesh will be exposed to air and direct sunlight. This increased exposure, specifically to sunlight, will allow for natural cleaning and disinfecting of the netting. This net cleaning method allows for a type of biological “reset” of the net pen, effectively preparing it for the next production cycle. In addition, this period of fallowing provides time needed for operational / logistical preparations prior to the start of the next production cycle. After the fallowing period, the net pen will be restocked with juvenile fish and the process will start again. This production approach minimizes the need for grading, which is ideal as the grading process is inherently stress-inducing for the fish. **Appendix L** contains the <u>theoretical</u> production and biomass timelines for the 5-year NPDES permit period (reflecting permit renewal after the initial 5-year period and an arbitrary start date of Jan 1, 2022), as well as production information and the resulting maximum biomass and feed rates. **Table 2** below summarizes the average and maximum production projections resulting from the tiered production method.

Table 2: *Average and Maximum annual fish production projections based on calendar years and tiered production. Assumes 11-month growout from 100g to 1.4kg. Actual production will vary depending on ideal harvest size and growth rate. Projections are based on the data and assumptions shown in* ***Appendix L****.*

	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Avg. (80% Survival)	212.8 MT	212.8 MT	1064 MT	1489.6 MT	2553.6 MT
Max (90% Survival)	239.4 MT	239.4 MT	1197 MT	1675.8 MT	2872.8 MT
# Harvests	1	1	5	7	12

These projections are based on several assumptions including stocking size, harvest size, growth rate, etc. MFF will implement an average target harvest density of approximately 25 $\mathrm{kg/m^3}$. This harvest density, combined with the estimated fish harvest size of 1.4 kg, results in the stocking of each net pen with approximately 190,000 fingerlings. The ideal size of these fingerlings at stocking is subject to their performance in offshore conditions as well as the production capabilities of the land-based hatcheries, but is estimated to be 100 g. However, the first two net pens deployed likely will seek to determine which stocking size is more ideal, with one of the pens being stocked with 50 g fish and the other being stocked with 100 g fish. The results of this experiment will inform future stocking and production. The production and biomass timelines in **Appendix L** incorporate this initial stocking size experiment. MFF is conservatively assuming a mortality rate of 20%, however actual mortality is expected to be less when the impacts of regular cleaning, thorough best management practices, and experienced staff are considered. Therefore, the maximum production projections assume a mortality rate of only 10%.

3.3.3. Harvest Method

The primary goal throughout the harvest process will be to minimize the stress that the fish experience. Harvest will be conducted manually by experienced staff utilizing seine nets to isolate a desired quantity of fish per day. The staff will be conservative in their use of the seine nets, making sure to isolate only what is required as to not unnecessarily stress the remaining fish in the net pen. The tender vessel, which will already be loaded with multiple harvest containers, will pull up alongside the surfaced net pens and tie up to them temporarily. Once the seine net has isolated the proper quantity of fish, a harvest dip net will be lowered into the seine net using the crane on board the tender vessel. The crane will then lift the fully loaded harvest net up and out of the net pen and swing over top of the harvest containers. A zipper on the harvest net will be released, and the fish will transfer into the harvest containers that contain the appropriate amount of saltwater ice slurry. The ice slurry will rapidly lower the fish's body temperature, rendering them dead in a matter of minutes. Once all of the containers on board the tender vessel are full, the tender will maneuver back to the support vessel to offload the full harvest containers. This process will be repeated until the required quantity of fish has been harvested. All harvested fish will be transported to shore in an ice slurry; however, other humane killing methods may be implemented prior to placing the fish in the slurry. The full harvest containers will then be transported back to the Port of Pensacola where they will be removed from the vessel and handed off to the processor / buyer.

3.4. Fish Species Information

MFF plans to culture Red Drum (*Sciaenops ocellatus*) at the intended offshore farm site. Red Drum are native to the Gulf of Mexico, and are an ideal candidate for marine aquaculture due to their inherent hardiness and well-established spawning and culture protocols. Per the Florida Department of Agriculture and Consumer Services (FDACS) Aquaculture Best Management Practices Manual, all broodstock for estuarine species must be collected within 100 km of the intended net pen site. The University of Southern Mississippi, on behalf of MFF, collected 17 adult Red Drum to serve as broodstock for the MFF project. The broodstock were collected from an area south of Fort Morgan, Alabama at a site approximately 100 km northwest of the MFF proposed site. These broodstock were transported to the Thad Cochran Marine Aquaculture Center (TCMAC) in Ocean Springs, MS, where they were quarantined to allow for the treatment and mitigation for any ecto-parasites that could cause issues in recirculating aquaculture systems. At the completion of the quarantine period, approximately four weeks after the last individual was stocked into the quarantine system, the adult Red Drum were transferred into several recirculating systems where their photothermal cycles will be manipulated to induce reproductive maturation and volitional spawning. As such, TCMAC will serve as the fingerling rearing location for the MFF project. MFF will utilize first generation offspring (F1 juveniles) for stocking of the offshore net pens. Fin samples have been collected from the broodstock for production of a genetic library as the MFF project evolves. Additional details regarding the red drum broodstock collection can be found in **Appendix M**.

3.5. Facility Geographic Location Information

The MFF preferred site, selected after an extensive NCCOS-CASS siting analysis and two subsequent baseline environmental surveys, is located at approximately 500642.3923 m easting, 3328482.03155 northing (NAD83 UTM Zone 16N) in approximately 50 m water depth. The MFF project team has positioned the farm footprint according to the hydrographic and geophysical data obtained during the BES surveys, as well as necessary setbacks recommended by the EPA and the Escambia County Marine Resources Division. Per NOAA National Marine Fisheries Service's update to the Gulf of Mexico Bryde's whale (now Rice's whale) core distribution area in 2019, the MFF preferred site is located approximately 4.5 km within the northernmost portion of the area, but in depths not considered to be primary core habitat for the Rice's whale (Rosel et. al, 2021). The western edge of the farm boundary is located the recommended 152.4 m (500 ft) from the Escambia County LAARS Artificial Reef area. The farm is also located such that the southernmost sources of discharge are a minimum of 1000 m from the stretch of known hard-bottom that lies to the southeast. The farm footprint includes a 31-meter internal buffer that encompasses all farm equipment. The total farm area is approximately 1.572 km^2 (388.5 acres). The coordinates of the preferred farm site are listed below in **Table 3**, and a detailed GIS map package that contains the farm layout, all associated coordinates, nearby ecological zones, and all BES data has been provided electronically and is also available upon request. All anchor coordinates are estimated within this map package, however the exact anchor locations will not be known until installation is complete.

Table 3: *MFF preferred site coordinates. Horizontal datum is NAD83, UTM Zone 16N. Units are meters.*

Farm Corner	Easting	Northing
South	500153.000	3327334.4132
Northwest	500153.000	3328739.3366
North	500922.4607	3329439.2465
East	501621.7817	3328670.4332

3.6. Support Vessel and Feed Barge Information

MFF plans to use multiple vessels throughout the 5-year NPDES permit cycle, subject to the expansion of the farm in terms of deployed net pens and subsequent biomass and feed requirements. MFF plans to begin operations using one support vessel and one tender vessel for the first year when there are only two net pens deployed. An additional support vessel and tender vessel of similar sizes are expected to be added to the operation for the second year, as the size of the operation doubles from two to four net pens. Once the project nears the third year (Phase 3), MFF will acquire and deploy a stationary feed-barge that will remain on-site permanently (with the exception of major storms). The barge will hold and deliver the feed required for the now six-net-pen farm and support day-to-day operations. The purpose of the support vessels will then transition to resupplying the barge with feed and supporting all stocking and harvest procedures. MFF will deploy an additional feed barge of similar size and capacity near the beginning of the fourth year to increase overall farm efficiency, decrease vessel trip frequency, and prepare for the final, 12-net-pen phase. There will be approximately six total vessels on-site when the farm is at full operation in Year 5. However, two of those vessels will be the support vessels, which will be dedicated to resupplies, stocking, and harvesting during this final phase and will likely never remain on-site for more than 24 hours. The total number of vessels that will remain on-site permanently when the farm is at full operation is four. **Table 4** shows the assumed accumulation of vessels over the course of the five-year period. The theoretical specifications of these vessels and barges and their intended uses are detailed below.

***Table 4**: Accumulation of farm vessels by year and production phase.*

	Year 1 (Phase 1)	**Year 2** (Phase 2)	**Year 3** (Phase 3)	**Year 4** (Phase 3)	**Year 5** (Phase 4)
# Net Pens	2	4	8	8	12
Support Vessel 1	x	x	x	x	x
Tender Vessel 1	x	x	x	x	x
Support Vessel 2		x	x	x	x
Tender Vessel 2		x	x	x	x
Feed Barge 1			x	x	x
Feed Barge 2				x	x

3.6.1. Support Vessels

Theoretical Support Vessel Specifications

- **Size**
  - Length: 36 m
  - Beam: 8 m
  - Draft: 3.6 m
  - Gross Tonnage: 89 MT
  - Net Tonnage: 77 MT
  - Deck Size: 16.5 x 7 m
  - Deck Capacity: 100 MT
- **Machinery**
  - Engine Size: (2) Detroit Diesel 16-V71
  - Speed: 10 knots
  - Generators: (2) Delco 40kW
    (2) Detroit Diesel 4-71
  - Deck Crane: 10 MT Knuckle Boom
- **Habitation**
  - Crew: 4
  - Berths: 6
  - Bunks: 17
  - Central heating and a/c
  - Galley and office/lab space

In addition to the four crew members, there will be a minimum of two trained staff members on board at all times. These USCG approved support vessels will be equipped with all required emergency communication devices as well as standard fire prevention systems.

Farm Usage

These support vessels will service a variety of tasks around the farm. They will support all cleaning, maintenance, and inspection procedures and carry all dive gear and farm-specific equipment such as seine nets, power washers, etc. The deck cranes will be utilized during harvest and mortality removal to lift the containers off the tender vessels. The large, open deck space of the support vessels will provide storage space for feed, circulation tanks (during stocking), and mortality and harvest containers. The vessels are expected to have an industry standard fish pump on board as well to assist in the stocking of the net pens in the least stressful manner possible. These vessels will also have full live-aboard capabilities for the entire crew and staff for extended periods of time.

The two main sources of noise on board these vessels will be the diesel engines and the diesel generators. The average diesel engine of the size listed has a sound level of approximately 105 dBA, and the average diesel generator of the sizes listed has a sound level of approximately 80 dBA. The exact amount of time this machinery will be in use is not known yet, but will be as infrequent as possible while still satisfying all requirements of the operation on a daily basis. This statement applies to light production as well. **Table 5** below provides a range of values regarding the support vessel's expected machinery and its anticipated usage. This usage is based on Year 1 and Year 2 of the project when one support vessel is the stationary source of power for the farm. MFF plans to incorporate renewable / green energy wherever both feasible and practical, and therefore anticipates the integration of hybrid power systems to satisfy the farm's energy demands. Diesel generators in conjunction with battery arrays would reduce generator run time and allow for decreased diesel consumption and decreased noise levels. MFF also plans to explore soundproofing options for generator / engine rooms to further decrease noise levels on the farm.

Table 5: *Estimated support vessel machinery and energy demand during periods of 2 net pens and 4 net pens.*

Support Vessel	Min	Max
Engine Size	(2) at 375 kW each	(2) at 525 kW each
Generator Size (kW)	(2) at 30 kW each	(2) at 50kW each
Generator Usage (hrs / day)	6.5	11.0
Light Wattage (watts)	150	300
Light Usage (hrs / day)	10	12

*Generator usage assumes (2) 30kW generators running at 75% capacity to meet a minimum demand of 300kWh/day (2 net pen farm) and a maximum demand of 500kWh/day (4 net pen farm)
*Generator usage assume the support vessel utilizes a hybrid power system of generators and battery arrays to meet the peak and base energy demands
*Light wattage and usage only refers the vessel's anchor lights and deck lights used overnight

Mooring and Transit

The size and storage capacity of these vessels combined with their offshore capabilities enables them to remain on site for extended periods of time. MFF plans to keep these vessels at the farm, fully staffed, for as long as weather conditions permit. The only routine trips the support vessels will make will be to restock feed, bring harvest to shore, or bring fingerlings out to the farm. Having the support vessels remain on-site regularly minimizes the number of trips back and forth to the farm, which has both economic and environmental advantages. The frequency of the necessary trips will depend heavily on the phase of the project and the time of year. The quantity and frequency of trips will be greater near the end of the growout cycles, when biomass and therefore feed consumption is the highest. The vessel trips will always be as efficient as possible, bringing feed out to the farm, and bringing harvested fish back to shore. Section 3.6.2 further details these trips and the methods used for estimating total trip quantity and frequency for years one and five of the NPDES permit. The speed and navigation of the vessels during these trips will be in accordance with NOAA Fisheries Southeast Regional Office Vessel Strike Avoidance Measures seen in **Appendix P**, and there will be spotters at the ready during transit to monitor for any marine life. The vessels will take the most direct route back and forth between the port and the farm site, observing any and all navigational restrictions that may exist in the area. The maps in **Appendix N** depict the expected vessel route between the farm and the entrance to Pensacola Bay.

Prior to the deployment of any feed barges, these vessels will utilize the two permanent moorings that are positioned within the farm to remain on-site. These are anticipated to be 8-point moorings, completely separate from the net pen moorings. The components of these moorings will be sized to accommodate the larger feed barges in later phases, and thus will be more than sufficient to safely moor the support vessels.

Discharge

The support vessels will adhere to all discharge guidelines and requirements throughout the project, and only items / quantities that have been deemed acceptable by the EPA will be discharged. All farm-specific waste will be brought back to shore for appropriate disposal / recycling. MFF’s operational plans will identify all farm-waste and describe the appropriate disposal processes.

3.6.2. Support Vessel Trip Estimates

As production increases over the four phases, the support vessels will be critical in maintaining all offshore operations. Feed barges will be deployed after the first two phases to mitigate the day-to-day responsibilities of the support vessels; however, the support vessels will be responsible for transport to and from the farm during <u>all</u> phases. There are three primary, routine reasons for support vessel trips: feed resupply, fish harvest, and fish stock. To provide detailed estimates regarding the quantity and frequency of these vessel trips, initial biomass estimates were extrapolated to yield monthly projections of total biomass present on the farm for all five years of the NPDES permit. These monthly biomass projections were then used to estimate required monthly feed totals for all five years of the permit. The monthly biomass and feed totals, in combination with the tiered production schedule, allowed for the estimation of all feed resupply trips, harvest trips, and stocking trips required for every month of the 5-year permit period. **Appendix O** tabulates these trip estimates and breaks them down into each of the three trip types. Values from these individual trip estimate tables were combined to generate a summary table (**Table 6**) of the total estimated monthly trips required for Year 1 and Year 5 during initial farm establishment and full production, respectively. The underlying assumptions for all estimates were based on previous operational experiences of the MFF project team. All major assumptions associated with each estimate are listed below their respective tables.

Table 6: *Estimated total monthly support vessel trips and monthly trip frequency for Year 1 and Year 5 of operations.*

Total Trips	Year 1	Year 5
Average # Trips per Month (for the year)	7.0	32.0
Average Frequency (Days per Month, for the year)	6.54	21.9

*All values represent the combination of feed, harvest, and stocking trips per month.
*Average trip per month values have been rounded up to the nearest whole number. Average frequency values are unrounded to allow for more accurate calculation of total days per year.
*One average value for the year for <u>feed</u> trips was derived by taking the average of the two different vessel size contributions. The same was done to derive one average value for stocking trips.
*These values <u>do not</u> account for efficiencies of combining harvest, feed, and stock trips (i.e. bringing harvest in, bringing feed back out).
*Average frequency for Year 1 assumes only one support vessel available to make trips and only one trip per day. Average frequency for Year 5 assumes two support vessels available to make trips and therefore the possibility of two trips per day.

Based on these estimates, MFF anticipates a total of approximately 84 routine support vessel trips during initial establishment of the farm in Year 1. With Year 1 operations relying on only one support vessel, the number of trips is limited to one per day and therefore the frequency is estimated to be an average of 6.54 days per month. However, a full trip is anticipated to take only eight hours in total, and therefore the actual time the support vessel is not on-site is equal to only one third of the 78.5 (6.54*12) trip days in Year 1. Accounting for inclement weather days that make vessel transit, mooring, and/or operation unsafe (assuming such days occur 15% of the year), this results in the support vessel remaining moored on-site for approximately 78% of the time in Year 1. The Year 5 values are representative of the farm operating at full production, with the assumption of operations continuing beyond the initial 5-year NPDES permit. MFF anticipates a total of approximately 384 routine support vessel trips during full production in Year 5. At this point of the operation the farm will rely on two support vessels, thereby enabling two trips per day and resulting in an average frequency of 21.9 days per month. It should be noted that neither the quantity nor frequency of trips in Year 5 account for efficiencies of combining harvest, feed resupply, and stocking trips. For example, it will be standard operating procedure for a support vessel to bring a day’s harvest from farm to port and then return to the farm full of feed. This combining of trips will drastically reduce both the total quantity and total frequency of trips for all years of operation.

While the feed barges will feature a robust seakeeping design and be capable of enduring most storms, there is a chance that the barges will be temporarily removed from the site if an extreme storm event (i.e. 10-year storm) is forecasted to encounter the farm site. With a 10% chance that 10-year storm conditions occur, or are exceeded, in any given year, the feed barges will remain moored on-site for approximately 90% of the time in years that they are deployed.

3.6.3. Tender Vessels

Theoretical Tender Vessel Specifications

- **Size**
  - Length: 12 m
  - Beam: 4.3 m
  - Hull Type: Catamaran
  - Draft: < 1 m
  - Deck Capacity: 8 MT
  - Deck Size: 6 x 3 m
- **Machinery**
  - Engine Size: (2) 250hp Outboards
  - Cruising Speed: 30 knots
  - Deck Crane: (2) 2 MT Knuckle Boom

Farm Usage

The tender vessels will be used by staff to maneuver around the farm and access each of the net pens individually on a day-to-day basis. They will support all daily operations such as cleaning, inspection, and maintenance while the primary support vessels remain moored. The tender vessels also will be used during harvest and mortality removal operations, as their small size enables them to temporarily tie up directly to the net pens for easy access to the fish.

These vessels will produce minimal noise and light due to their small size, and whatever is produced will be comparable to any recreational boat in the Gulf of Mexico.

Mooring and Transit

These smaller vessels will traverse the farm site on a daily basis and will remain on the farm, only travelling back and forth to shore on certain occasions (i.e. extreme weather or bringing personnel to or from the farm). These boats also will adhere to the NOAA Fisheries Southeast Regional Office Vessel Strike Avoidance Measures during their infrequent trips to and from shore.

These vessels are small enough that they can rely on the primary support vessel or feed barge for mooring when not in use. They will likely be tied up alongside the support vessel or feed barge, or potentially craned up and out of the water to be stored on the deck of the support vessel during storm events.

Discharge

There will be no discharge associated with the tender vessels due to their small size and limited machinery.

3.6.4. Feed Barges

Theoretical Feed Barge Specifications

- **Size**
  - Length: 31.5 m
  - Beam: 12.5 m
  - Draft: 2.85 m
  - Feed Capacity: 450 MT
  - Number of Silos: 6
- Machinery
  - Engine Size: N/A
  - Speed: N/A
  - Generators: (2) 50kW
- Habitation
  - Crew: 6
  - Bunks: 6
  - Central heating and a/c
  - Galley and office/lab space

Farm Usage

Stationary feed barges will be deployed starting in Phase 3 once the biomass and subsequent volume of feed is such that a combination of on-site barges and support vessels is needed to achieve maximum efficiency. These barges, designed to be moored in high-energy locations, have the ability to remain on-site and simultaneously feed numerous net pens. They will use floating feed hoses in conjunction with a water-blown feed system to deliver feed to the net pens at distances up to approximately 500 m. The size of these barges enables them to hold several hundred tons of feed, and provide full living and office / lab space for crew and staff. The barges will supplement the support vessels and serve as the “headquarters” of the operation, supporting all day-to-day tasks. As such, the tender vessels will tie up to the barges instead of the support vessels when not in use. Once the barges are deployed, the purpose of the support vessels will transition to resupplying the barges with feed and supporting all stocking and harvest procedures.

These barges are not expected to be mobile, and therefore will not have engines. The main source of noise onboard these barges is expected to be the diesel generators. The exact size, quantity, and usage of these generators is not yet known, but will be as infrequent as possible while still satisfying all requirements of the operation on a daily basis. This statement applies to light production as well. **Table 7** below provides a range of values regarding the feed barge's expected machinery and its anticipated usage. This usage is based on Year 3 of the project when one feed barge is the stationary source of power for the farm. The feed barges are expected to incorporate efficiency and noise reduction measures similar to those of the support vessels.

Table 7: *Estimated feed barge machinery and energy demand during periods of 6 net pens and 8 net pens.*

Feed Barge	Min	Max
Engine Size	---	---
Generator Size (kW)	(2) at 50kW each	(2) at 75kW each
Generator Usage (hrs / day)	8.5	10.5
Light Wattage (watts)	150	300
Light Usage (hrs / day)	10	12

*Generator usage assumes (2) 50kW generators running at 75% capacity to meet a minimum demand of 650kWh/day (6-net-pen farm with one feed barge) and a maximum demand of 765kWh/day (8-net-pen farm with one feed barge)
*Generator usage assumes the feed barge utilizes a hybrid power system of generators and battery arrays to meet the peak and base energy demands
*Light wattage and usage refers to the barge's anchor lights and deck lights used overnight

Mooring and Transit

MFF plans to keep these barges at the farm, fully staffed, for as long as weather conditions permit. These barges will be capable of withstanding adverse weather conditions, but will be removed from their moorings and towed back to port ahead of any major storm or hurricane forecast to exceed the barge's maximum design conditions.

These barges will be moored using the two, aforementioned 8-point mooring systems that will be permanent installations at the farm. All mooring components will be sized to accommodate the size and mass of the barges. As stated previously in Section 2.2.3, the exact specifications of the barge mooring components will be subject to the input of the feed barge manufacturer, however, estimates of component size, strength, and material are provided.

Discharge

The feed barges will adhere to all discharge guidelines and requirements throughout the project. Only items / quantities deemed acceptable by the EPA will be discharged. All farm-specific waste will be brought back to shore for appropriate disposal / recycling. MFF's operational plans will identify all farm-waste and describe the appropriate disposal processes.

3.7. Drug and Vaccine Information

All drug, vaccine, and fish health management information is detailed in the draft Fish Health Management plan in **Appendix K**. The plan was developed by the MFF project team in consultation with Stephen Frattini DVM of the Center for Aquatic Animal Research and Management. As stated in Section 5.6.5 of the Fish Health Management Plan, MFF reserves the right to use any drug / therapeutant of Low Regulatory Priority as defined by the FDA. MFF will not use any drug banned by authorities in the United States and Canada for use in aquacultured food fish. Should any drug / therapeutant / antibiotic be deemed necessary by MFF management and prescribed by the attending veterinarian, it will be mixed in with feed designated specifically for the fish / net pen of concern and administered with due diligence. With the exception of the medicated feed, it is unlikely that any drug / therapeutant will be administered in the growout phase due to the inherent open-environment system of the net pens. Any drug / therapeutant that is administered likely would be used during the nursery and transport phases when the fish are in a closed environment where concentrations can be properly contained and controlled. MFF has no plan to utilize any investigational new animal drugs (INAD) or participate in any INAD testing and/or extra-label drug use at this time.

3.8. Cleaning and Maintenance Procedures

MFF will implement regular and thorough cleaning and maintenance of the entire farm throughout all phases of the project. This will be done using a combination of trained divers, ROVs, and underwater cameras. All cleaning of the net pens will be performed by certified open water divers utilizing industry standard pressure washers to remove all accumulated organic matter from the nets and other surfaces. This cleaning will be performed a minimum of once per week, with increased frequency expected during summer months when fouling is more prevalent due to warmer water temperatures. With the exception of the direct air and sunlight exposure method used during the fallowing period, all cleaning of the net pens will be done with a pressure washer and/or similar mechanical cleaning method. No chemicals will be used to clean the net pens or any other equipment that remains in the water. The use of divers for regular net cleaning allows for increased human observation of both farm components and fish behavior. This human observation will be crucial for informing day-to-day farm operations, as all divers will be trained to identify any anomalies on the farm. Fish mortalities will be collected by the divers using specialized nets. Once the diver has placed all mortalities in the net, the net will be lifted up and out of the water using the crane on the tender vessel. The mortalities will then be transferred into designated, secure containers and transported back to port for proper disposal. (MFF also plans to explore opportunities to convert the mortalities into organic compost and / or biogas in an effort to increase the sustainability of the operation.) The frequency of mortality removal will be weekly, and concurrent with the cleaning process. The divers will also perform routine inspections of all farm components while they are on-site and underwater. Specifically, they will inspect all net pen hinges and net connections, as well as the nets themselves for any holes or tears. These inspections will be performed at least once per week, and immediately following any major storm event. The net pens will be surfaced during all cleaning and maintenance procedures, and potentially raised above the surface for specific cleaning or inspection purposes using the same air-lift system that brings the net pen up from its submerged configuration. With the net pens in the surfaced configuration, entry will be through the main top net, which will be temporarily detached in certain areas (not fully removed) and re-attached and tensioned upon completion of the procedures. Underwater cameras will also be used for inspection purposes and to monitor fish behavior. ROV's will be deployed with some frequency, especially following storm events to inspect mooring components that are deeper in the water column and not accessible to divers. A comprehensive Net Pen Structure and Mooring System Preventative Maintenance Program will be developed and implemented in accordance with the EPA's Best Management Practices plan and FDACS's Aquaculture Best Management Practices Manual. This program will identify all net pens, mooring systems, and associated farm components, and schedule and document regular maintenance and inspection. A comprehensive Solid Waste Management Plan will also be developed and implemented in accordance with the EPA's Best Management Practices plan and FDACS's Aquaculture Best Management Practices Manual. This plan will minimize potential marine debris by identifying all waste generated and describing how said waste will be collected and disposed of responsibly.

3.9. Containment Measures

Each StormSafe® Submersible Net Pen will utilize a multi-net system for the containment of the fish. The main interior net, expected to be a 2" stretch polyethylene material, will encompass all eight sides (top and bottom included) of the net pen. Each side will be tensioned using the net pen's designated netting infrastructure, which consists of attachment loops welded onto the vertical spars and horizontal pipes, and small pulleys mounted on the bottom of the vertical spars and lower connector pieces. The pulleys enable the netting to be pulled tight and tied off, effectively securing them to the net pen. This tensioning will prevent "billowing" of the netting in strong waves and currents. Should a nursery net be needed during the early weeks of the offshore growout cycle, a net with a smaller, more appropriate stretch size will be deployed within the main net and tensioned in the same manner. Once the fish reach a size suitable for the main net, the nursery net would be removed by disconnecting it from the infrastructure and sliding it out from underneath the fish, effectively containing them within the main net. The stretch size of the main nets and nursery nets will always be significantly less than the cross-sectional width of the fish being contained. The most appropriate stretch size to contain the fish initially stocked into the net will be determined in consultation with the net mesh manufacturers and the land-based hatchery staff at TCMAC. Predation from marine species will be prevented using a predator net (not to exceed 3.5" stretched with either size #36 or #42 twine braided or twisted) outside of the main net. This predator net will encompass seven sides of the net pen. The top of the StormSafe® will feature only the main net, as predation from the top is only a concern due to birds when the net pen is surfaced, and the main top net is properly suited to keep birds out. The predator netting will be attached to the net pen using the same method as the main nets.

Should the contaminant prevention tarps be required at any point, they too would attach to the net pen structure (on the six vertical sides) and be tensioned via the pulleys.

3.10. Farm Installation and Decommissioning Details

3.10.1. Installation

The farm installation process will follow the phased deployment approach. All gear will be installed with the same methods, regardless of project phase and net pen quantity. An experienced, local marine contractor will be subcontracted to provide installation services. The exact methodology, equipment, schedule, etc. will be determined upon consultation with the contractor, however the general process will be as follows.

Site-Marking Navigational Buoys

1. The contractor will mobilize the required work vessels and/or barges to the MFF site, carrying all necessary mooring gear for the day's intended installations.
2. Upon arrival at the site, the contractor will use the provided GPS coordinates to deploy the four site-marking navigational buoys at the corners of the permitted area for site reference and subsequent navigational aid. The mooring components for these corner buoys will be assembled on the deck of the installation vessel/barge.
3. Once these components are assembled, they will be deployed by lowering the deadweight anchor and attached mooring line to the seafloor at the intended GPS location. The surface end of the anchor line will be attached to a temporary mooring buoy, so it remains at the surface while the navigational buoy is lowered into the water using the vessel's crane. The mooring line will be attached to the navigational buoy, and the temporary buoy will be removed.
4. Installation of these four site-marking buoys will be brief and is expected to be completed in less than half a day's work.

Drag Embedment Anchors and Mooring Lines

1. All primary mooring line components will be assembled either on land or on the deck of the anchor handling vessel (AHV), such that the entire mooring line and anchor assembly is ready for deployment once on-site. The mooring lines will be deployed one at a time until all six are installed per net pen.
2. To ensure proper embedment of the drag anchors, a temporary work line will be attached to the surface end of the mooring line to increase the mooring line scope. This additional scope will allow for a strictly horizontal load to be applied to the anchor during drag embedment which is crucial for achieving maximum anchor penetration and therefore maximum holding capacity.

3. Each drag embedment anchor will be carefully lowered down to the seafloor at a location approximately 25 m away from the intended final anchor location. The contractor will utilize GPS coordinates provided for both the anchor drop location and the intended final location to ensure the anchors are deployed in the designated locations within the farm footprint. Once the anchor makes contact with the seabed and is oriented properly, the AHV will maneuver towards and then past the intended final anchor location until the entirety of the mooring line and work line assembly is paid out. At this point, the AHV will slowly begin to apply tension to the line, increasing thrust gradually until the tension reaches the maximum design load determined in the hydrodynamic analysis shown in **Appendix I**.
4. The line tension, line angle, and anchor drag distance will be monitored during the anchor installation process. The anchors are anticipated to drag approximately 20 m before reaching their ultimate holding capacity. An ROV will be used to verify proper anchor behavior such as orientation, drag distance, and anchor penetration throughout the installation.
5. Once an installed anchor is confirmed to resist the full design load, the AHV will maneuver back toward the anchor, retrieve the temporary work line, and disconnect it from the end of the mooring line. At this point, the mooring line will be attached to a temporary surface float so that the line can be retrieved easily for the next step of the deployment. This process will be repeated until all six anchors and mooring line are deployed per net pen.
6. The anchors will then be left unloaded (no net pen or spar buoys attached) for 2-4 weeks to allow for "set-up" to have its maximum effect. This period of time with no applied load allows the disturbed soil to reconsolidate around the anchor and provide increased holding capacity.
7. Once the set-up period is complete, the anchors will be proof tested to ensure that they will resist the worst-case conditions (with respect to typical drag anchor horizontal-only loading) predicted by the hydrodynamic analysis. Two proof tests will be completed, one representing the peak vertical load scenario and the other representing the maximum uplift angle of the anchor chain with respect to the seafloor. If the anchors hold steady during these proof tests, the mooring lines will then be ready for connection to the system.
8. Installation of these drag anchors and their mooring lines is expected to require one day's work per net pen system (six anchors).

StormSafe® Net Pens and Surface Spar Buoys

1. The StormSafe® net pens will be partially assembled within Pensacola Bay, and then towed to the farm site for installation.
2. In approximately 14 m of water, a depth that is considered attainable within Pensacola Bay, the skeletal structure of the StormSafe® net pens will be assembled in an iterative process.

3. The six main vertical spars and six horizontal lower connectors will be loaded onto the support vessel first and brought to the required depth within the bay. These twelve steel pipes (capped at both ends) will be lowered into the water horizontally, one at a time, alternating between main spars and lower connectors. The lower connectors will be bolted to the bottoms of the main spars using custom hinge joints, such that they will extend out perpendicularly from the base of the main spars. This process will be repeated, moving the vessel in a circle until all six spar assemblies are complete. At this point, the bottoms of all six main spars will be unified by the six lower connectors, forming a "wheel and spoke" shape when viewed from above.
4. Once all of the spars and lower connectors are connected, the bottom chambers of the six main spars will be flooded with seawater. This will alter the hydrostatics of the structure, and cause the main spars to rotate and orient themselves vertically as the structure adjusts to reach equilibrium once again. The system is designed so that the added mass of the flooded bottom chambers causes the structure to come to rest with only the top few meters of the main spars remaining above the waterline.
5. Once the bottom connectors are installed and the main spars are oriented vertically, the remaining six pipes that unify the tops of the spars and form the walkways can be installed. These walkway pipes will be loaded onto the vessel and transported to the partially assembled net pen. The vessel's crane will slowly lower them into position between adjacent spars, and they will be bolted to the hinges located on the top caps of the spars.
6. Once the framework of the net pen is fully assembled, it will be towed from Pensacola Bay to the farm site using one of the support vessels. The six surface spar buoys, their respective bridle lines, and the net mesh will be brought to the site at this time on the deck of the support vessel.
7. Upon arriving at the site, the surface spar buoys will be deployed. The padeye located on the bottom of each spar buoy will be attached to its respective mooring line via the shackle termination present on the surface end of each mooring line.
8. Prior to positioning the net pen within the mooring system, the crane on the support vessel will lower the netting into the net pen and the top edges of the net will be fastened to the rails of the walkways as designed.
9. With the netting partially installed, the bridle lines will then be attached to the remaining padeyes on the buoys, and the net pen will be moved into place using the support vessel and smaller tender vessels. The free ends of the bridle lines will then be connected to their respective corner spars one at a time, using the vessels to maneuver the net pen accordingly.
10. Lastly, divers will be deployed to complete the subsurface net mesh to net pen connections and to inspect all components.
11. Assembly and installation of the StormSafe® net pen, its surface spar buoys, and the netting is expected to take three day's work per net pen system (one net pen and six surface spar buoys).

Feed Barges and Moorings

1. The feed barge(s) will also be moored with a catenary line and drag anchor system. Therefore, their installation will follow the same general protocol as that of the net pen moorings. The installation process of the barge moorings will be the same as described above in steps 3-6 of the net pen mooring, except for the use of a temporary working line since the barge mooring lines contain sufficient scope for proper drag anchor installation.
2. Once the feed barge anchors have been left to set for 2-4 weeks, a tugboat supplied by the marine contractor or the feed barge company will be mobilized to tow the barges offshore to the site.
3. The barge will be connected to its moorings one side (two mooring lines) at a time. The tug vessel will position the barge such that all eight mooring lines can be attached to the barge. Once all eight lines are attached, the barge installation is complete.
4. Installation of the feed barge and its moorings is expected to take three day's work per barge system, not including the anchor set-up period.

The total time required for Phase 1 installation of the two-net-pen farm is expected to be 4-6 weeks when accounting for the anchor set-up period. The maximum time required for installation will be 5-7 weeks for Phase 3, as this will involve the addition of four new net pens.

3.10.2. Decommission

Decommissioning will include the removal of all gear in its entirety. Depending on the input of the marine contractor hired for the removal process, the process will be as follows.

Feed Barges and Moorings

1. The feed barges and their moorings will be removed first to free up space for removal of the remaining gear. All feed lines will be cleared of any residual feed, retrieved, and coiled on board the barge prior to its removal.
2. A tug vessel will be used to tow the barge back to the Port of Pensacola. Upon arrival at the site, the tug will connect a tow line to the barge, and then apply a slight load in one direction such that the two, now slackened mooring lines can be detached from the barge. This process will be repeated with all four sides of the barge until all eight mooring lines are detached. The detached mooring lines will have a temporary mooring buoy connected to their free end so they remain at the surface for later removal. With the barge isolated from the farm system and from its respective moorings, the tug vessel will tow the barge back to shore.
3. Once the feed barges have been removed from the farm, their moorings will be removed. This will be done by connecting the free end of the mooring line to the AHV, and maneuvering the vessel back to and then past the anchor location. Once the vessel is past the anchor, it will apply a vertical force to the mooring line in the direction opposite to

anchor embedment. Doing so will dislodge and free the anchor from the seafloor, allowing it to be winched up to the surface by the mooring line and placed on board the AHV. The mooring lines will be disconnected from the anchors and coiled intact or disassembled depending on any future usage. The anchor removal process will be the same for all drag anchors.
4. Removal of the feed barge and its moorings is expected take one day's work per feed barge system.

StormSafe® Net Pens and Surface Spar Buoys

1. The StormSafe® net pens and their spar buoys will be removed in the reverse order of how they were deployed.
2. The support vessel will work with smaller tender vessels to maneuver the net pen such that the bridle lines can be disconnected. The support vessel will then tow the net pen out of its position and into an open area so that divers can remove the netting. The divers will disconnect the net mesh from its attachment points so it can be lifted from the water using the crane on board the support vessel.
3. The tender vessels and divers will then disconnect the surface spar buoys from the mooring lines so they can be loaded onto the deck of the support vessel. All of the removed gear will be transported back to port for proper storage.
4. The net pen structure will be towed back to Pensacola Bay and disassembled in the same manner in which it was assembled. The crane on the support vessel will remove the walkway pieces and place them on the deck of the vessel. The bottom chambers of the main spars will be filled with air, thus removing the ballast water and causing the spars to rotate back to their horizontal orientation as the bottoms of the spars rise to the surface. Once the spars are horizontal and the bottom connectors are at the surface, they will be disconnected and lifted onto the vessel. The vessel will return to the Port of Pensacola facility and all StormSafe® components will be stored properly.
5. Removal and disassembly of the net pens and their surface spar buoys is expected to take three day's work per net pen system.

Drag Embedment Anchors and Mooring Lines

1. With the surface spar buoys disconnected, the removal of the net pen mooring lines and anchors will be the same as described above in step 3 of *Feed Barge and Moorings*.
2. Removal of the drag anchors and their mooring lines is expected to take half a day's work per net pen system.

Site-Marking Navigational Buoys

1. The site-marking buoys will be removed in the reverse order of how they were deployed. A temporary mooring buoy will be attached to the mooring line, and the navigational

buoy will be detached from the mooring line. The support vessel will lift the navigational buoy onto the deck using its crane, and then winch in the mooring line until the deadweight anchor comes to the surface. At this point, the mooring line assembly will be coiled or disassembled depending on any future usage.

2. Removal of the site-marking navigational buoys is expected to be completed in less than half a day's work.

The total time required for decommissioning of the 12-net-pen farm is expected to be 8-10 weeks.

3.11. Draft Plans for Monitoring and Emergency Response

The MFF project team is in the process of developing comprehensive plans for environmental monitoring, protected species monitoring, and emergency response. The MFF project team will work directly with the EPA to develop environmental monitoring and emergency response plans that adhere to all the requirements and conditions specified in the EPA NPDES permit and other federal permits. The MFF project team will work also with NMFS SERO to develop a protected species monitoring plan that is appropriately suited for the GOM project. All of these plans, as well as other operational plans to be submitted, will adhere to the requirements and conditions defined in the EPA Aquaculture Plans outline and will also align with the recommendations set forth by FDACS' Aquaculture Best Management Practices Manual.

3.12. Potential Shoreside Socio-economic Impacts

MFF is currently planning to utilize a port facility in the Port of Pensacola, FL as a base of operations for the offshore farm. The facility is expected to be the primary landing site for all harvested fish, and will support the offshore operation throughout all phases of the project. The number of MFF employees working locally will vary throughout the phases of the project, but MFF estimates 35-40 employees dedicated to farm-related operations, and 10-12 office and sales related staff during the final phase of the project. In addition to the salaried staff, MFF will hire independent contractors as needed throughout the project. MFF will also focus on utilizing local processors and distributors for harvest and sale of product.

3.13. Buoy and Navigational Aid Information

The farm will be marked by four permanent surface buoys, one at each corner of the farm footprint. These buoys will contain lights with appropriate visibility in accordance with all USACE and USCG regulations. The MFF project team contacted the Aids to Navigation (ATON) Officer for the USCG, Sector Mobile. It was determined that the MFF project team will submit a request to the USCG to designate the four corner buoys as Private Aids to Navigation (PATONs), and upon approval these buoys will be added to the USCG Light List and recognized on NOAA Electronic Navigation Charts (ENC) for proper demarcation of the farm. The MFF project team also contacted the local NOAA Marine Chart Division (MCD) to determine how the farm would appear on ENC's and what attributes it should have. NOAA MCD recommended the farm contain a "Cautionary" notice on the ENC that would provide further information on the restrictions and contents of the farm as it relates to mariners and safe navigation. The following table details the requested ENC attributes of the farm, using ENC terminology, as understood by the MFF project team. The restriction (RESTRN) attributes selected by the MFF project team represent both operational and safety considerations, and are intended to apply only to the area <u>within</u> the farm footprint. Therefore, all activities unauthorized by and/or unrelated to Manna Fish Farms will be <u>prohibited</u> within the designated and demarcated farm footprint. This will include entry into the farm footprint. However, in the interest of education, outreach, and stakeholder engagement, Manna Fish Farms will permit, on a case-by-case basis, authorized limited access to the farm for approved activities. Any access to the farm will require prior written consent and accompaniment by a designated MFF staff member. The approved activities may include recreational fishing and recreational diving. Manna Fish Farms reserves the right to establish the type and extent of approved activities, within the confines of Manna's federal permits and state certifications. The restriction (RESTRN) attributes selected by the MFF project team <u>may</u> be subject to further regulatory consultation and adjustment. These restrictions and notices were selected, in part, to dissuade unauthorized vessels from entering the farm and interacting with farm equipment and fish stock. Limiting farm access also serves to avoid significant increases in vessel traffic in the area. In addition, Manna's operational plan is such that the site will be completely unoccupied only rarely or for short durations. Rare situations would include significant storm events (during which it is highly unlikely that an unauthorized vessel would choose to enter the farm) and support vessel maintenance during Year 1 (when the farm is operating with only one support vessel). Short durations would include support vessel resupply trips during Year 1, during which the site would likely be left unattended overnight for a maximum of 12 hours. All mooring buoys will be clearly labeled and state that unauthorized mooring is prohibited.

Table 8: *NOAA Marine Chart Division ENC attributes of the farm as determined by the MFF project team. All codes, attributes, and designations are MCD ENC terminology.*

S-57 Geo Object	S-57 Attribute	Allowable Encoding Value
Marine farm / culture (MARCUL)	CATFMA	3: Fish
	WATLEV	7: Floating
	QUASOU	1: Depth known
	RESTRN	1: Anchoring prohibited 3: Fishing prohibited 5: Trawling prohibited 7: Entry prohibited 9: Dredging prohibited 11: Diving prohibited 13: No wake 15: Construction prohibited 16: Discharging prohibited 18: Industrial or mineral exploration/development prohibited 20: Drilling prohibited 22: Removal of historical artifacts prohibited 23: Cargo transhipment (lightering) prohibited 24: Dragging prohibited 25: Stopping prohibited 26: Landing prohibited 27: Speed restricted
	STATUS	1: Permanent 12: Illuminated 16: Watched

3.14. Existing Water Quality and Sediment Data

At present there is no available information at or near the proposed farm location summarizing existing water quality data. Per EPA's Environmental Monitoring Plan requirements, the collection of water quality data will commence prior to the installation of any gear and prior to the stocking of any fish. This initial data will serve as a baseline for water quality comparisons as the project progresses. The Baseline Environmental Surveys performed in 2019 and 2020 did not collect any physical sediment samples for analysis. However, the sub-bottom profile data collected in both surveys allows for the inference of some general sediment physical characteristics. The acoustic results suggest a sandy substrate with minimal relief, with the exception of the hard-bottom ridge feature detected in the southeast corner of the surveyed area outside of the farm's footprint. See Section 6.1 of **Appendix H** for further details regarding inferred sediment properties. Sediment samples will be collected prior to any installation or stocking.

3.15. Timeline and Tentative Schedule

Milestone Activity	Start Date	Finish Date	Months
Pre-Application			
University of Southern Mississippi Receives Grant for Finfish Aquaculture Operation from Gulf States Marine Fisheries Commission (GSMFC)	June 2018	June 2018	1
Manna Fish Farms Identified as Commercial Finfish Operator for GSMFC Grant	Aug 2018	Aug 2018	1
NOAA CASS Siting Analysis for MFF GOM	Oct 2018	Nov 2018	2
Department of Defense Notice Received	Feb 2019	Feb 2019	1
Baseline Environmental Survey #1	Apr 2019	May 2019	2
First Presentation to Gulf of Mexico Fishery Management Council	June 2019	June 2019	1
Baseline Environmental Survey #2	Dec 2020	Dec 2020	1
Collect Native Red Drum for Broodstock	Mar 2021	Mar 2021	1
Hydrodynamic Engineering Analysis of StormSafe® Net Pen in GOM Environment	Jan 2021	May 2021	5
Second Presentation to Gulf of Mexico Fishery Management Council	June 2021	June 2021	1
Submit Interagency Request for Information Response	June 2021	Oct 14, 2021	4
Receive Interagency Request for Additional Information	Oct 14, 2021	Jan 31, 2022	4
Submit Interagency Request for Additional Information Response	Jan 31, 2022	Apr 4, 2022	2
Application			
Permit Applications Submitted to ACE and EPA	Jan 31, 2022	Apr 4, 2022	2
CZMA Consistency Determination Submitted	TBD	TBD	
Deploy StormSafe® Net Pens and Support Vessels*			
Lease Port Facility	1 month post	1 month post	1
Order Net Pens and Mooring Equipment	1 month post	1 month post	1
Purchase Support and Tender Vessels	1 month post	1 month post	1
			1
Install Net Pens and Mooring Equipment*			
Install Phase 1 Mooring Gear	3 months post	3 months post	1
Install First Two Net Pens	3 months post	3 months post	1
Rear First Two Cohorts of Red Drum*			
Fingerling Production	2 months post	4 months post	3

Stock First Two Net Pens	4 months post	4 months post	1
Feeding, Cleaning, and Monitoring	4 months post	End of project	--
Water Quality and Benthic Monitoring	2 months post	End of project	--
Stakeholder Engagement and Public Outreach	Ongoing	Ongoing	--
Source Buyer(s)/Processor(s)/Distributor(s)	Ongoing	1 month post	--
Harvest First Two Net Pens	15 months post	15 months post	1

*Start and finish dates are estimated post-permit issuance

References

[1] Turpin, Robert K. v.2009.1 ed., Escambia County Marine Resources Division, 2009, *Escambia County Artificial Reef Plan*.

[2] Johnston, Robert K, et. al Space and Naval Warfare Systems Center, 2006, *Ex-Oriskany Artificial Reef Project: Ecological Risk Assessment*.

[3] Zhou, Q.C., Tan, B.P., Mai, K.S. & Liu, Y.J. 2004. *Apparent digestibility of selected feed ingredients for juvenile cobia Rachycentron canadum. Aquaculture, 241:441-451.*

[4] Patricia E. Rosel, Lynsey A. Wilcox, Tadasu K. Yamada, and Keith D. Mullin. 2021. *A new species of baleen whale (Balaenoptera) from the Gulf of Mexico, with a review of its geographic distribution. Marine Mammal Science. Volume 37, (2): 577-610.*

Appendix A:

Manna Fish Farms Pre-Application Checklist 9-11-18

Pre-Application Meeting Checklist:

Manna Fish Farms

Applicant:

Manna Fish Farms
22 Inlet Road West
Hampton Bays, NY 11946
Attn: Donna Lanzetta
Phone:
Email: donna@mannafishfarms.com

Agent: Thad Cochran Marine Aquaculture Center (TCMAC)
University of Southern Mississippi
703 East Beach Dr.
Ocean Springs MS 39564
Attn: Kelly Lucas
Phone: 228-818-8026
Email: kelly.lucas@usm.edu

Background:

Manna Fish Farms is led by Donna Lanzetta, CEO, a business leader and entrepreneur born and raised in the Town of Southampton, which is located on the eastern end of Long Island, in New York State. Manna Fish Farms has assembled a first-class team of local and worldwide marine scientists, biologists, engineers, aquatic veterinarians, along with aquaculture, operational and educational experts to implement this important ocean farming initiative. Manna Fish Farms is committed to transparency, and to the use of best aquaculture practices to grow and supply healthy seafood in a sustainable manner. Manna Fish Farms is currently permitting a finfish farm off New York and is expanding operations to the Gulf of Mexico. For permitting the finfish farm in the Gulf of Mexico, Manna Fish Farms is collaborating with a team from The University of Southern Mississippi (TCMAC), University of Mississippi (Mississippi-Alabama Sea Grant Legal), University of New Hampshire (New Hampshire Sea Grant) and NOAA, National Center for Coastal Ocean Science. Partial funding for permitting the farm in the Gulf of Mexico is through the Gulf States Marine Fisheries Commission.

List of Species:

Red drum (Scianeops ocellatus)
Almaco jack (Seriola Rivoliana)
Cobia (Rachycentron canadum)
Pompano (Trachinotus carolinus)
Spotted Sea Trout (Cynoscion nebulosus)
Gray Snapper (Lutjanus griseus)
Tripletail (Lobotes surinamensis)
Red Snapper (Lutjanus campechanus)

Annual Production Plan:
If 18 cages are harvested in one year the maximum amount of harvest would be 5,400,000 lbs.

Production by phase (numbers listed as maximum):
Phase 1: 600,000 lbs annually (2 cages), year 0-1
Phase 2: 1,200,000 lbs annually (4 cages), years 2-3
Phase 3: 3,600,000 lbs annually (12 cages), years 3-5
Phase 4: 5,400,000 lbs (18, cages) years 5-10

Daily Estimated maximum feed (in pounds) of feed and description of feed type to be used for feeding fish in offshore cages:

Estimated Feed Usage:
Feed Frequency will vary depending on species, size of fish and biomass. Feed Conversion Ratio will also vary by species but for estimation on the high end will be 2lbs of feed to 1lb of fish. Daily estimated feed has been calculated based on the maximum amount of feed per day at initial harvest. At a minimum per 8000m^3 cage, 275lbs/day (125kg/day) will be required at stocking up to 5353lbs/day (2,848 kg/day) near harvest.

Estimated food usage
Phase 1: 12557 lbs/day (5696kg/day)
Phase 2: 24939 lbs/day (11312kg/day)
Phase 3: 74816 lbs/day (33936kg/day)
Phase 4: 112,224 lbs/day (50,904kg/day)

The feed buoy will provide daily rations to the submerged cages through 4" dia. HDPE pipe. Initially, fish will be fed 6 times/day. As they grow, the intervals will be reduced to 2-3 feedings/day. Fish are not fed 2 days prior to harvest. In the buoy, feed and seawater is mixed together in a closed chamber before being pumped to center of the cage. The slow sinking feed is controlled and monitored via underwater cameras. As feed behavior slows, feeding stops.

Description of feed type*:* Slow sinking pellet with estimated 40-50% protein and 10% lipid will be selected. However, nutritional components may vary by species. Source will be a recognized national supplier.

Siting Information:
<u>Site A (4th Choice):</u> No high resolution multibeam data available for site. Lower resolution bathymetry suggests a slight slope with a few ridges across the site. Bathymetry borders the 50 m depth threshold, which is the minimum depth required by engineers. It borders high traffic tug and tow. It borders Military Operating Area W-155A, and is in Special Use Airspace W-155A (likely a drawing error in GIS – should verify with Department of Defense).

<u>Site B (5th Choice):</u> A small amount of high resolution multibeam data available for site. Lower resolution bathymetry suggests a large depression is present in site, with a high slope. The site borders a shipping lane and traffic with tug and tow vessels. It borders Military Operating Area W-155A, and is in Special Use Airspace W-155A (likely a drawing error in GIS – should verify with Department of Defense).

Site C (3rd Choice): High resolution multibeam data available most of site, indicating a relatively level sea floor with a few ridges. It is located in Military Operating Area W-155A, and Special Use Air Space W-155A. The site is close to a shipping lane.

Site D (2nd Choice): High resolution multibeam data available for entire site. Data suggest a sandy level seafloor. The site is located away from the shipping lane and other vessel traffic. USGS surficial sediment classification is sand. The site is located in Military Operating Area W-155A, and Special Use Air Space W-155A.

Site E (1st Choice): High resolution multibeam data available for whole site. Closest of the sites to Pensacola and NMFS approved landing locations. The site is located far away from shipping lanes and has very low vessel traffic. It is located well within Military Operating Area W-155A, and Special Use Air Space W-155A. This is the closest potential site to Pensacola that is > 50m deep. There is a ridge present in the site, but the topography across the site is generally level.

Table 1. Proposed Site estimated distance in nautical miles to Pensacola and to closest Fish House, with Center coordinates of site.

Site	Distance to Pensacola channel exit	Distance to closest Fish House	Center X	Center Y
A	23.9 nm	24.0 nm	-87.245995	29.919509
B	24.6 nm	25.0 nm	-87.257095	29.0962
C	25.0 nm	25.5 nm	-87.255272	29.903322
D	25.5 nm	26.0 nm	-87.250808	29.896699
E	21.7 nm	17.0 nm	-86.987038	30.077558

Lat/Long:

Table 2. Proposed Site Corner Coordinates (GCS NAD 1983).

Site	X	Y
A	-87.2405	29.92285
A	-87.2469	29.92284
A	-87.2516	29.91737
A	-87.2452	29.91547
B	-87.2623	29.9118
B	-87.2552	29.91182
B	-87.2489	29.90981
B	-87.2493	29.90915
B	-87.26	29.90703
B	-87.2623	29.90687
C	-87.2597	29.90073
C	-87.2597	29.90589
C	-87.2508	29.90591
C	-87.2508	29.90075
D	-87.2561	29.89638
D	-87.2493	29.90111
D	-87.2455	29.89702
D	-87.2523	29.89229
E	-86.988	30.07297
E	-86.9923	30.07656
E	-86.9861	30.08215
E	-86.9818	30.07856

Table 3. Data layers examined for each site, N/A means data layer was not applicable to siting. Distances given in nautical miles (nm) are distance measured between the site and the data object nearest to it. For example, Site A is 14. 5 nm from the Submerged Land Act Boundary.

Data Layer Examined	Site A	Site B	Site C	Site D	Site E
Bathymetry	NA	NA	NA	NA	NA
Submerged Land Act Boundary	14.5 nm	15.5	15.5 nm	16 nm	7.6
Surficial Sediment Classification	-	-	-	-	-
Military Operating Areas	No	No	Yes	Yes	Yes
Special Use Airspace	Yes	Yes	Yes	Yes	Yes
Unexploded Ordnance	24 nm	24 nm	24 nm	24 nm	17.6
Military Ship Shock Boxes	45 nm	45 nm	45 nm	45 nm	56 nm
Military Regulated Airspace	No	No	No	No	No
Military Submarine Transit Lanes	No	No	No	No	No
Formerly Used Defense Sites	12 nm	12 nm	12 nm	12 nm	11 nm
Military Danger Zones and	23 nm	23 nm	23 nm	23 nm	9 nm
Fish Havens	5.0 nm	5.8 nm	6.0 nm	6.3	0.4
Artificial Reefs	2.8 nm	3.6 nm	3.8 nm	4.1	5 nm
Shipwrecks	4.8 nm	4.2 nm	4 nm	3.5	2.2
Obstructions	14 nm	14.8	1.9 nm	2 nm	8 nm
Shipping Lanes	0.6 nm	0.02	0.16 nm	0.34	10 nm
AIS Cargo Vessel Traffic	low	none	none	low	none
AIS Tanker Vessel Traffic	none	none	none	none	none
AIS Tug &Tow Vessel Traffic	low/med	med	low/med	low	none
AIS Pleasure Vessel Traffic	low	low	none	none	low
AIS Passenger Vessel Traffic	low	none	none	low	low
AIS Other Vessel Traffic	low	low	low	low	low
AIS Fishing Vessel Traffic	low	low	low	none	low
Pilot Boarding Areas	N/A	N/A	N/A	N/A	N/A
Anchorage Areas	15 nm	15.5	16 nm	16.5	15 nm
Coastally Maintained Channels	21 nm	21.6	22 nm	22.4	19 nm
Aid to Navigation	1.2 nm	1.8 nm	2 nm	2 nm	15 nm
Lightering Zone	40 nm	39 nm	39 nm	39 nm	56 nm
Oil & Gas Platform	32.6 nm	32.5	33 nm	33 nm	45 nm
Oil & Gas Well	1.5 nm	2.1 nm	2.4 nm	2.5	13 nm
Oil & Gas Active Lease	1 nm*	1 nm*	1 nm*	1 nm*	10 nm
Oil & Gas Pipeline	9.2 nm	8.4 nm	8 nm	7.5	22 nm
Submarine Cable	55 nm	55 nm	55 nm	55 nm	67 nm
Shrimp Effort	none	none	none	none	very
Ocean Disposal Sites	11.8 nm	12.3	12.5 nm	13 nm	15 nm
Wind Planning Areas	N/A	N/A	N/A	N/A	N/A
Active Renewable Energy Leases	N/A	N/A	N/A	N/A	N/A
Federal Sand and Gravel Borrow	57 nm	57.8	58 nm	58.2	70 nm
Sand Resource Blocks	9.2 nm	8.5 nm	8.7 nm	9 nm	23 nm
Protected Areas	20.8 nm	21.5	22 nm	22.5	15 nm
Deep Sea Coral	4.5 nm	3.4 nm	3.2 nm	2.8	18nm
Cetacean BIA	6 nm	6.3 nm	6.1 nm	5.5	2.6
Coral 9 HAPC	31 nm	30 nm	29.5 nm	29 nm	46 nm
Coastal Critical Habitats	23 nm	23.8	24 nm	24 nm	21 nm
Coastal Barrier Resources	No	No	No	No	No
Pulley Ridge EFH	No	No	No	No	No
Reef and Bank EFH	No	No	No	No	No
Coral EFH	No	No	No	No	No
Spiny Lobster EFH	No	No	No	No	No
Coastal Migratory Pelagic EFH	Yes	Yes	Yes	Yes	Yes
Red Drum EFH	No	No	No	No	No
Shrimp EFH	Yes	Yes	Yes	Yes	Yes
Reef Fish EFH	Yes	Yes	Yes	Yes	Yes

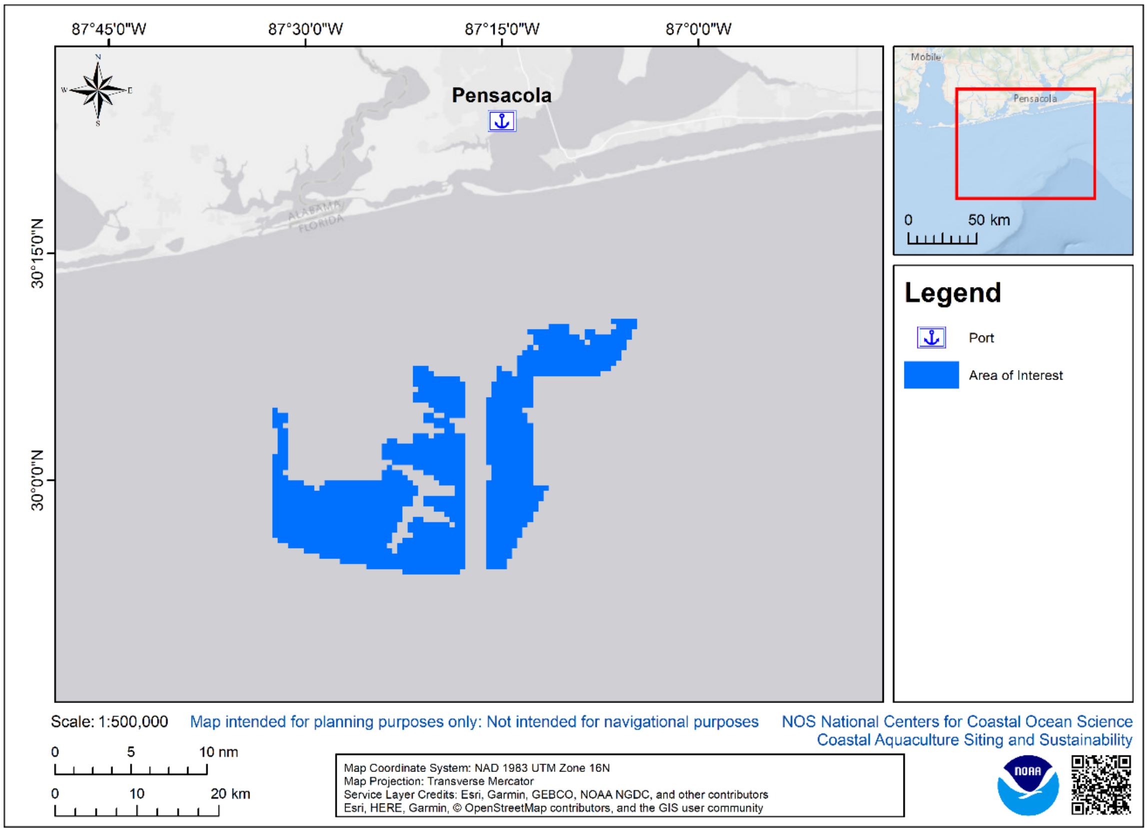
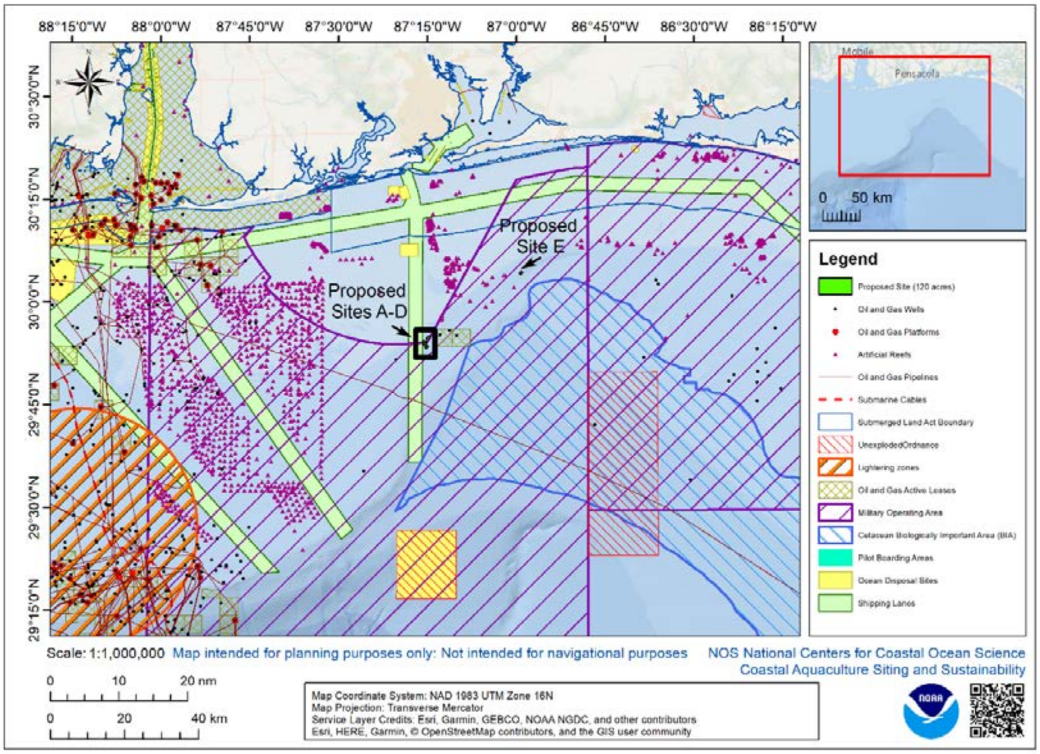
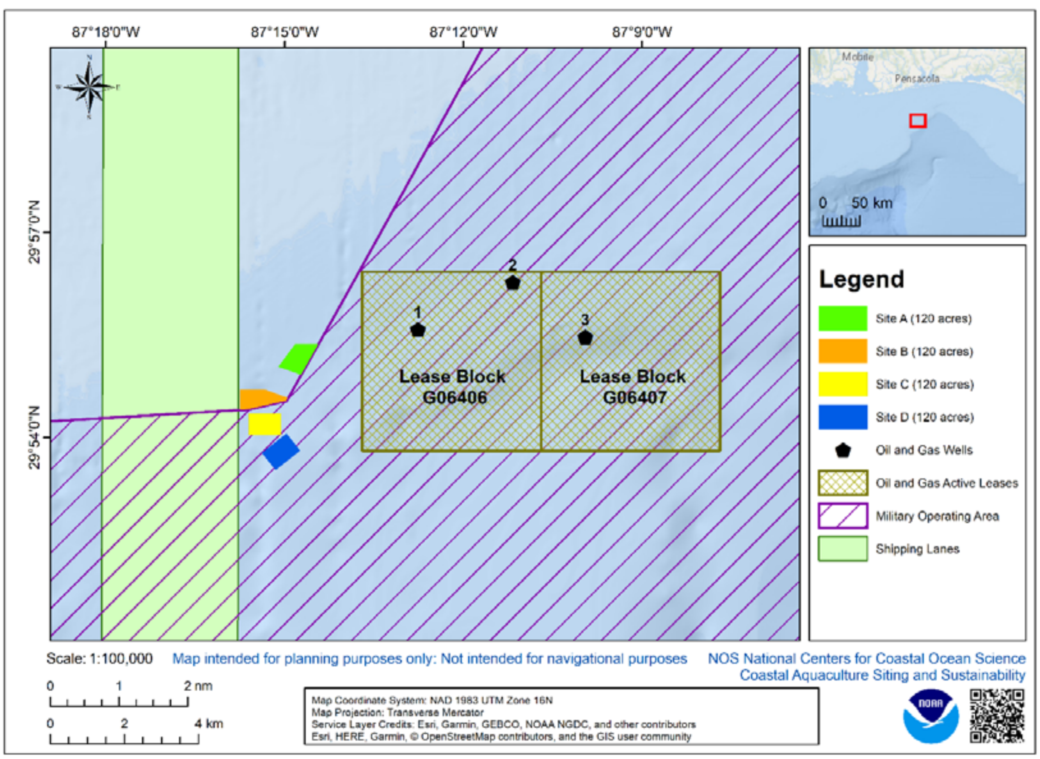


Figure 1. Eastern planning area. Note: Site C, D, and E were not in the original Area of Interest, as these sites are located in the Military Operating Area (originally excluded).



2a

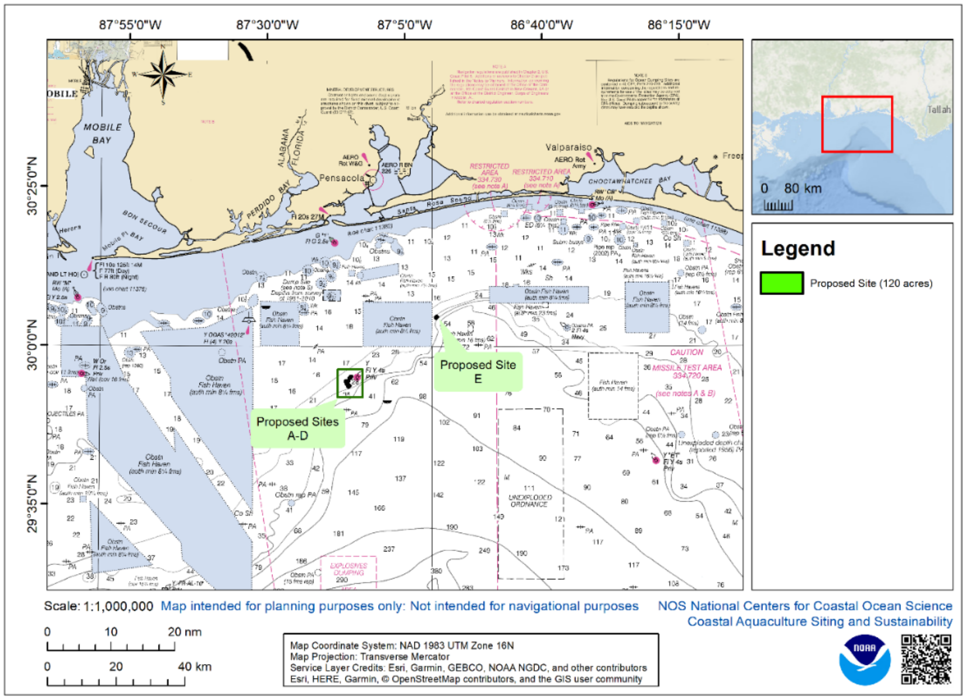


2b

Figure 2a. Proposed site locations with other use areas mapped. **2b.** Three oil and gas wells in two active lease blocks, G06406 and G06407, are located nearby the proposed sites. Both lease blocks were effective on 2/1/1984, and both currently hold the status of Unitized.

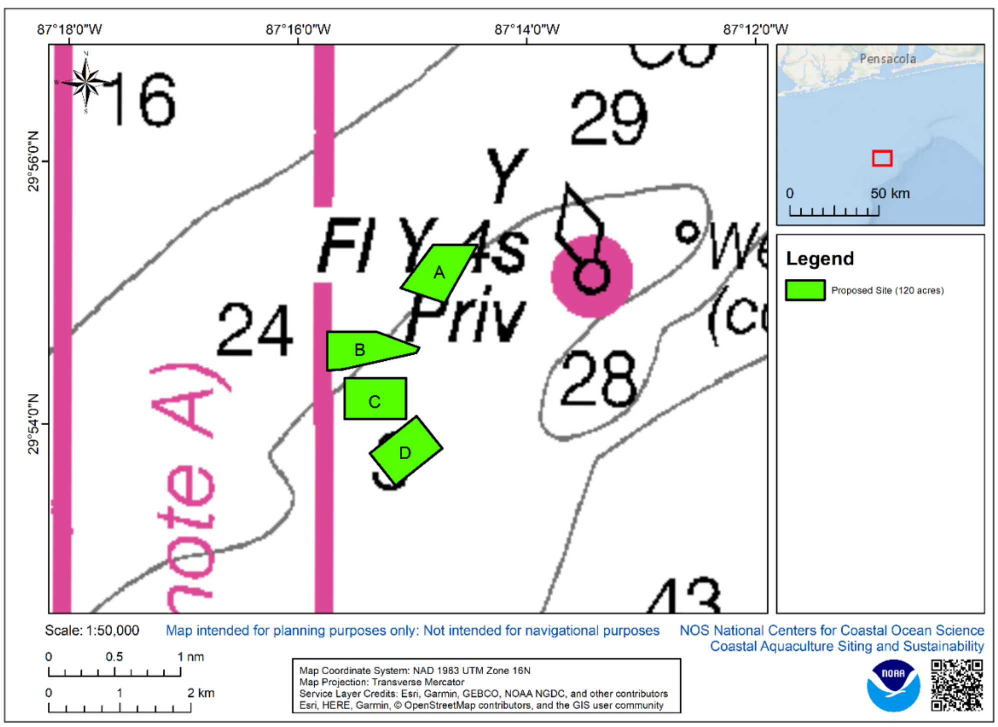
Table 4. Metadata for the three oil wells in the two lease blocks G06406 and G06407, which were put into effect on 2/1/1984. The Spud date, or initial drilling dates ranged from 1987 to 1996. The status of all three wells is Temporarily Abandoned.

ID	x	y	Depth (ft)	API Number	Operator	Spud Date	Type	Status
1	-87.212628	29.92631	187	608224003970	2647	10/31/1989	Exploratory	Borehole Side Tracked
1	-87.212628	29.92631	187	608224003900	2647	10/12/1990	Exploratory	Temporarily Abandoned
2	-87.186073	29.937835	187	608224003570	2647	6/12/1987	Exploratory	Borehole Side Tracked
2	-87.186073	29.937835	187	608224003500	2647	12/14/1987	Exploratory	Temporarily Abandoned
3	-87.165784	29.924611	244	608224004170	2647	11/7/1995	Exploratory	Borehole Side Tracked
3	-87.165784	29.924611	244	608224004100	2647	2/19/1996	Exploratory	Temporarily Abandoned



87°55'0"W
87°30'0"W
87°5'0"W
86°40'0"W
86°15'0"W
30°25'0"N
30°0'0"N
29°35'0"N
MOBILE BAY
Pensacola
Valparaiso
Proposed Site E
Proposed Sites A-D
0 80 km
Legend
Proposed Site (120 acres)
Scale: 1:1,000,000
Map intended for planning purposes only: Not intended for navigational purposes
NOS National Centers for Coastal Ocean Science
Coastal Aquaculture Siting and Sustainability
0 10 20 nm
0 20 40 km
Map Coordinate System: NAD 1983 UTM Zone 16N
Map Projection: Transverse Mercator
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

3a



87°18'0"W
87°16'0"W
87°14'0"W
87°12'0"W
29°56'0"N
29°54'0"N
16
29
Y
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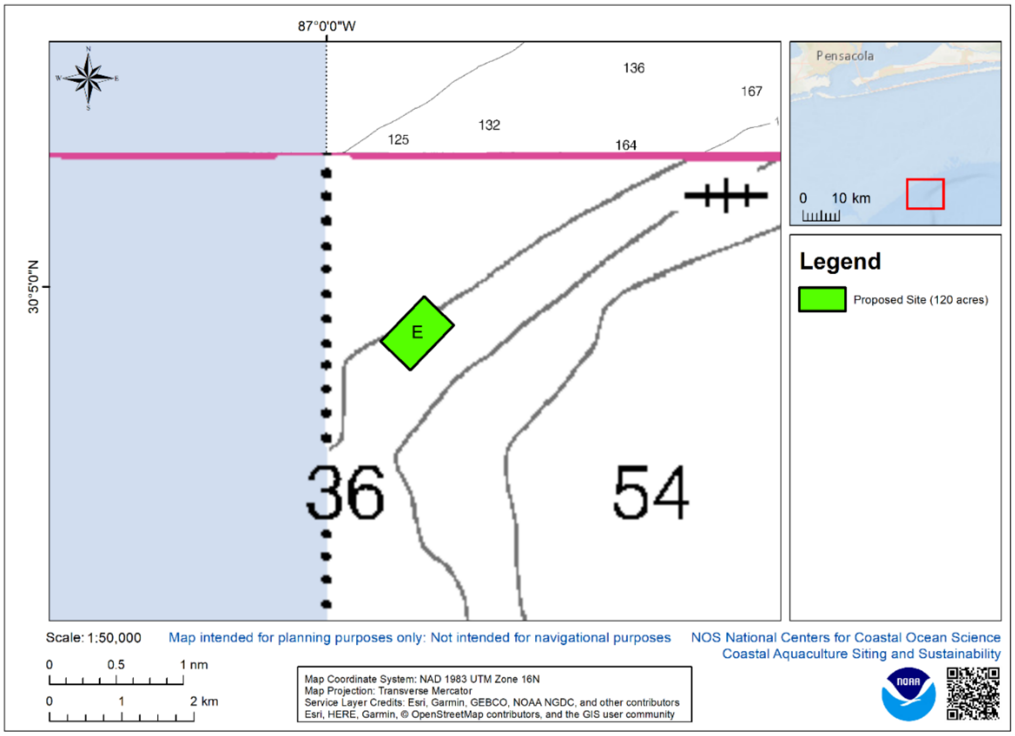
Priv
24
28
43
note A)
A
B
C
D
Pensacola
0 50 km
Legend
Proposed Site (120 acres)
Scale: 1:50,000
Map intended for planning purposes only: Not intended for navigational purposes
NOS National Centers for Coastal Ocean Science
Coastal Aquaculture Siting and Sustainability
0 0.5 1 nm
0 1 2 km
Map Coordinate System: NAD 1983 UTM Zone 16N
Map Projection: Transverse Mercator
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

3b



3c

Figure 3a. Locations of sites A-E on Nautical Charts**. 3b.** Proposed sites A-D on Nautical Charts. **3c**. Proposed site E on Nautical Charts

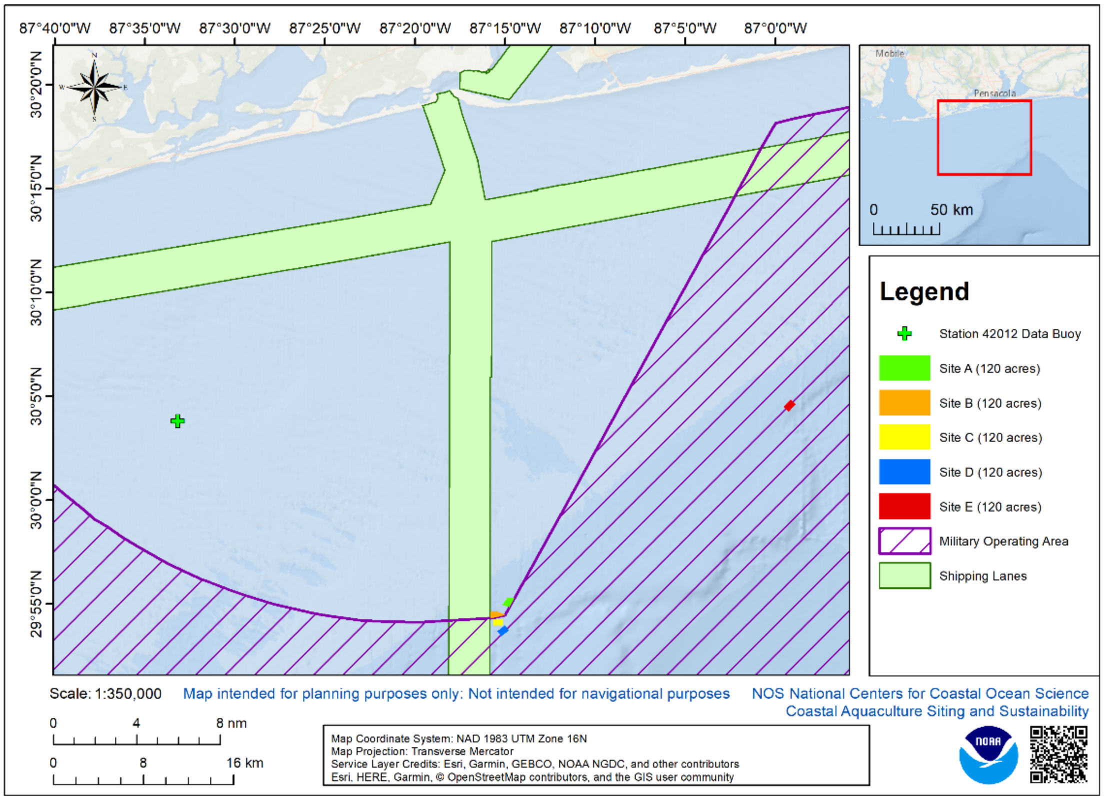


Figure 4. National Data Buoy Center Station 42012 Data Buoy shown on map in relation to proposed sites.

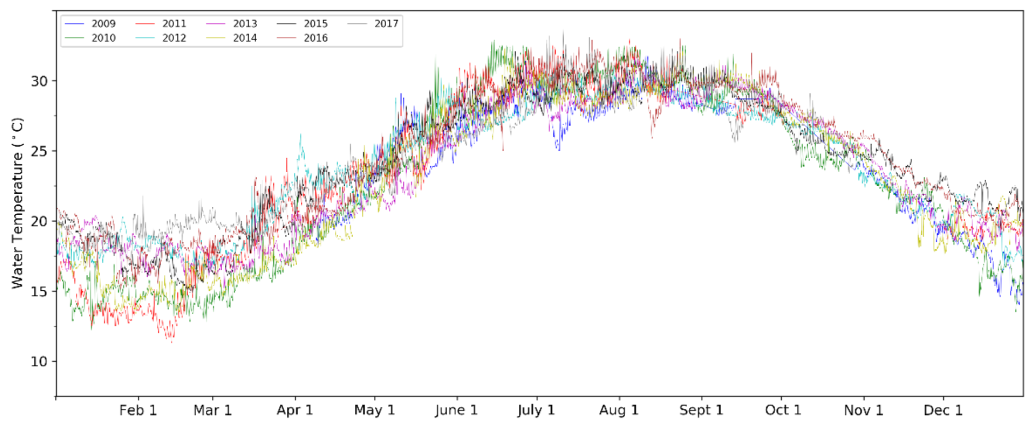


Figure 5. Hourly Sea Surface Temperatures from Jan. 1 to Dec. 31 displayed for 2009 to 2017

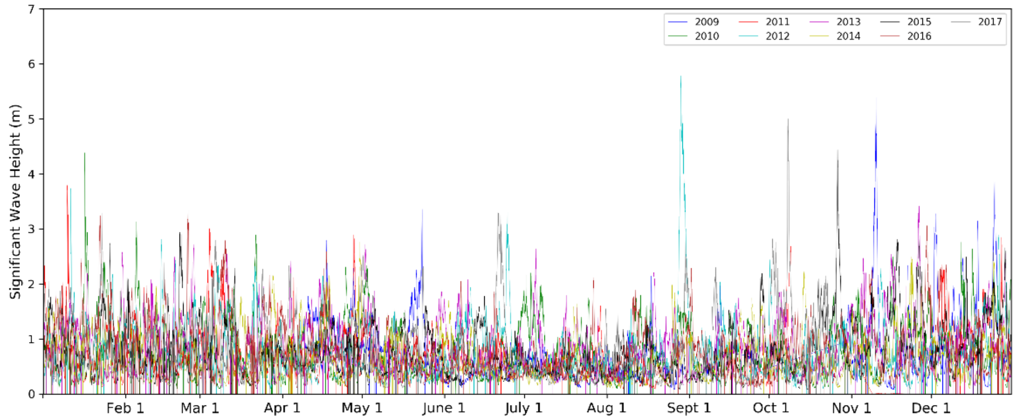


Figure 6. Hourly significant wave heights observed from Jan. 1 to Dec. 31 displayed for 2009 to 2017

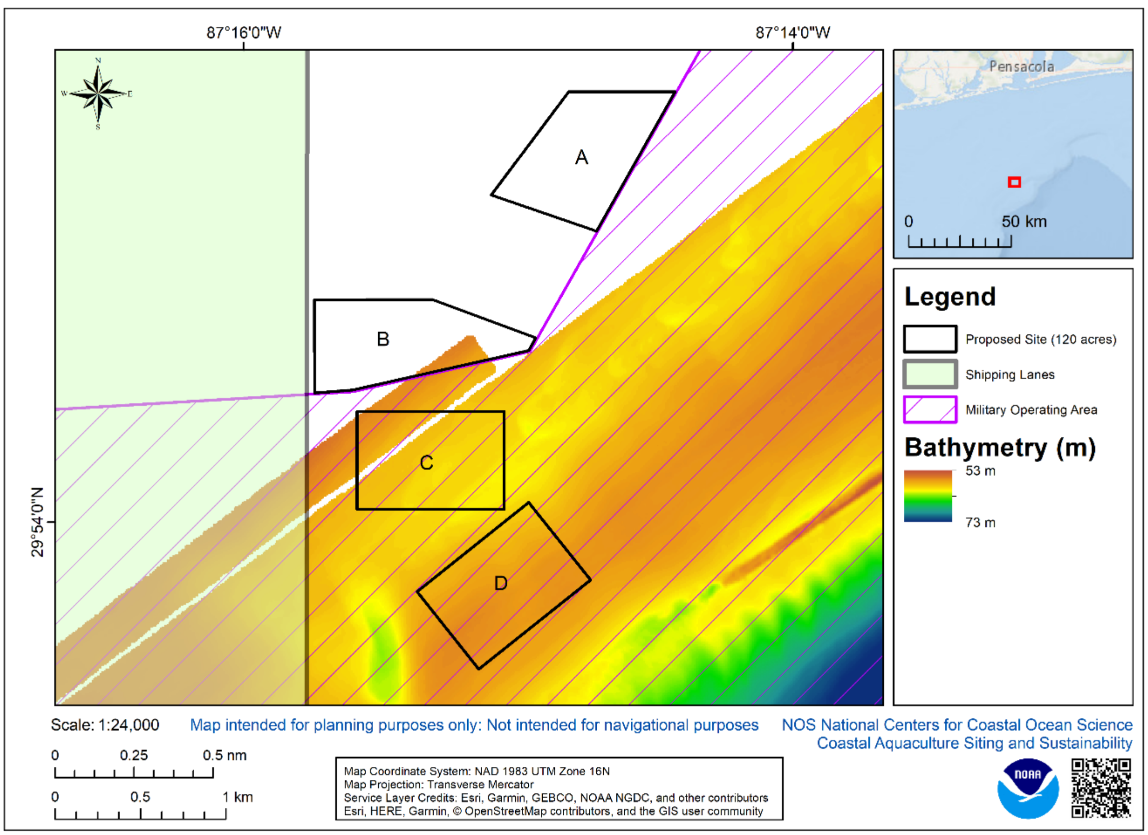


Figure 7. Multibeam bathymetry available for proposed aquaculture sites.

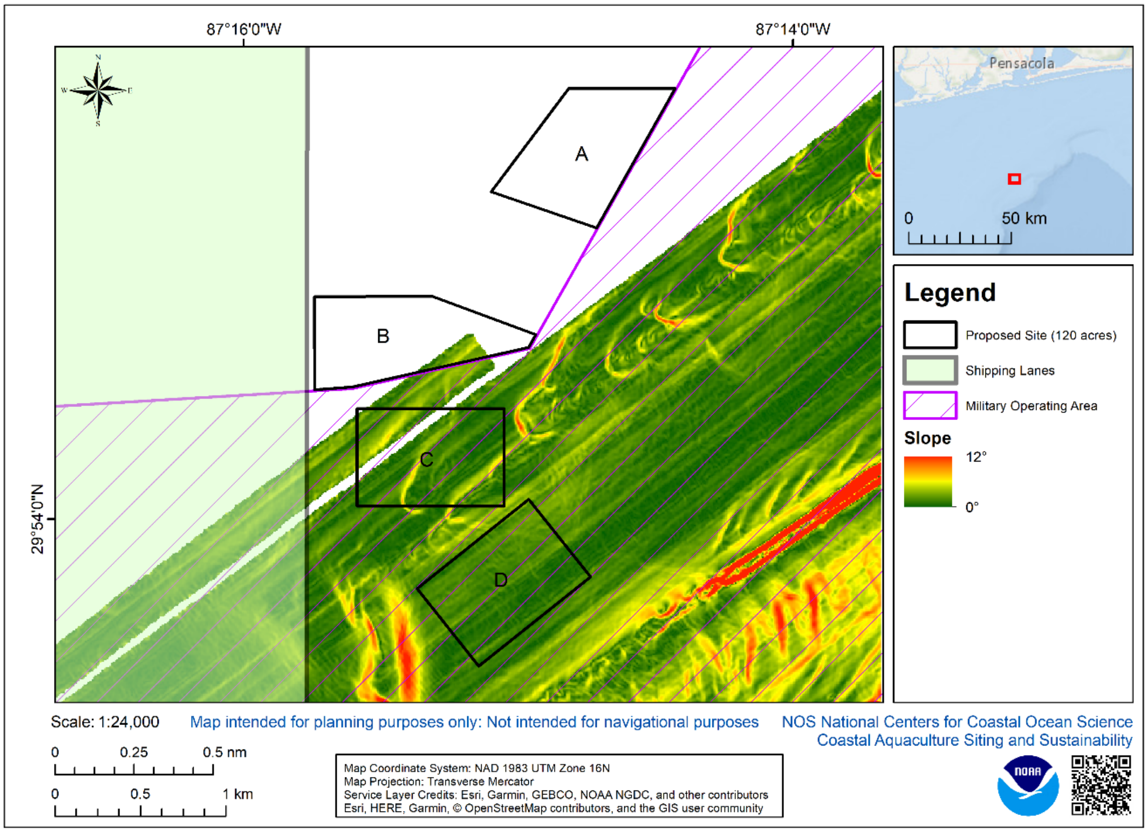


Figure 8. Slope of seafloor determined from multibeam bathymetry available for proposed aquaculture sites.

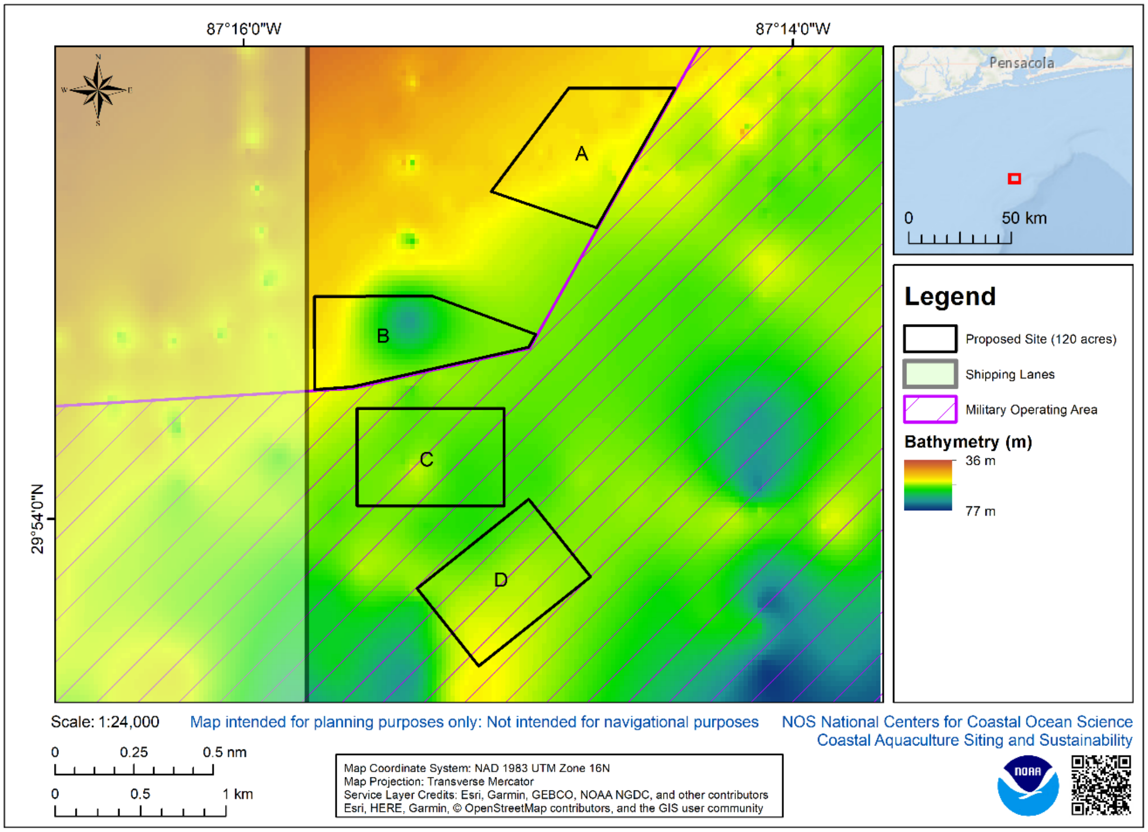


Figure 9. Bathymetric profile (30x30 m resolution) for proposed aquaculture sites.

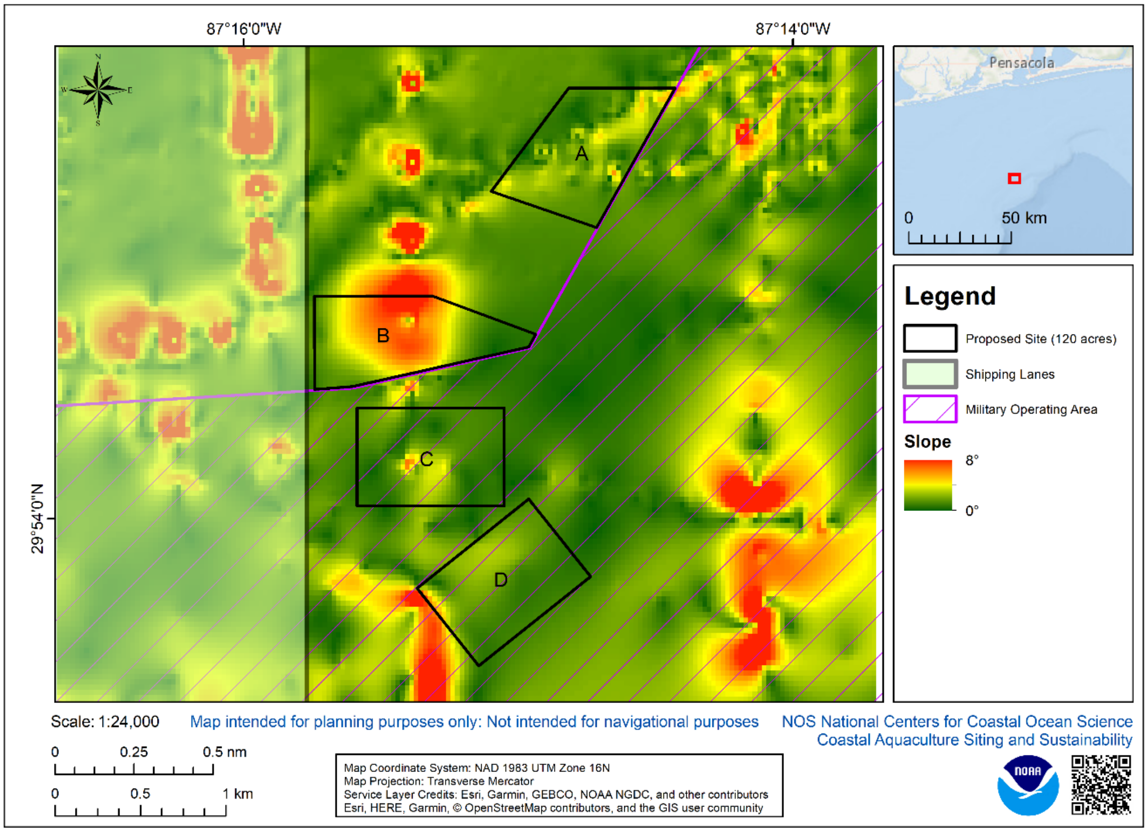


Figure 10. Seafloor slope based upon bathymetric profile (30x30 m resolution).

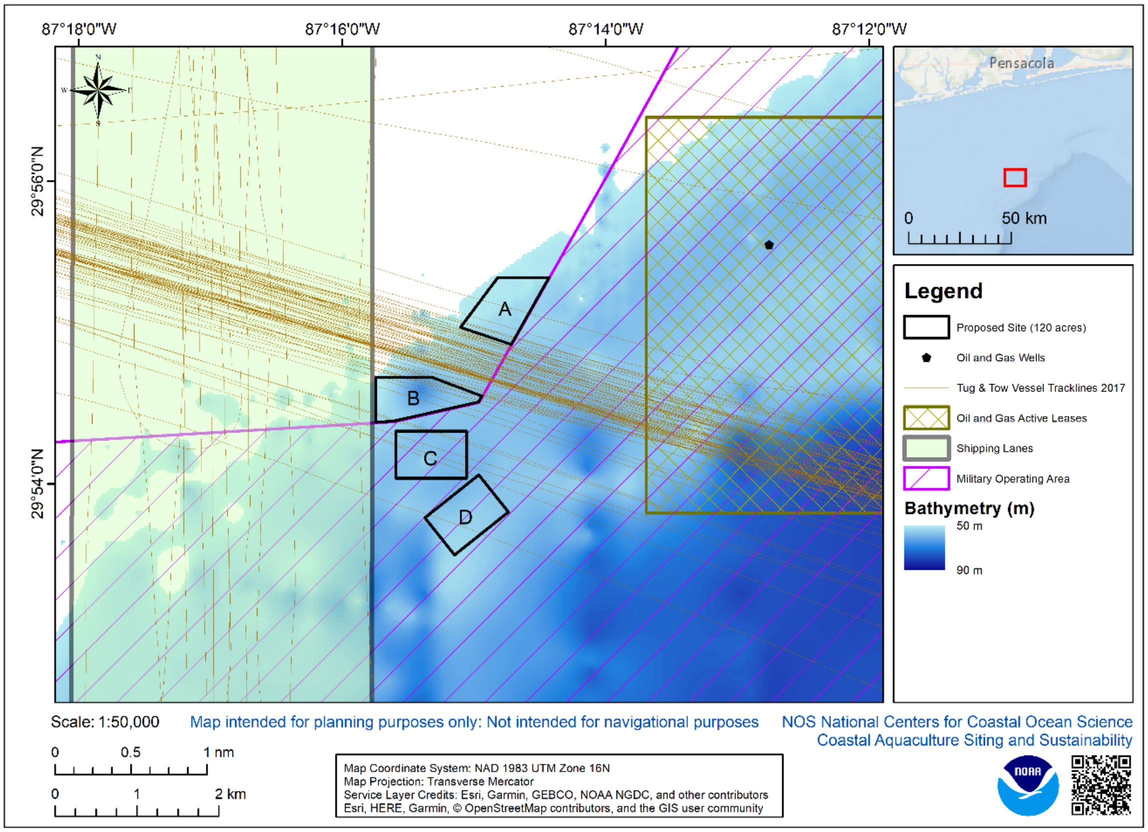


Figure 11. Bathymetry (>50 m) with vessel traffic as determined from 2017 AIS Tug and Tow data.

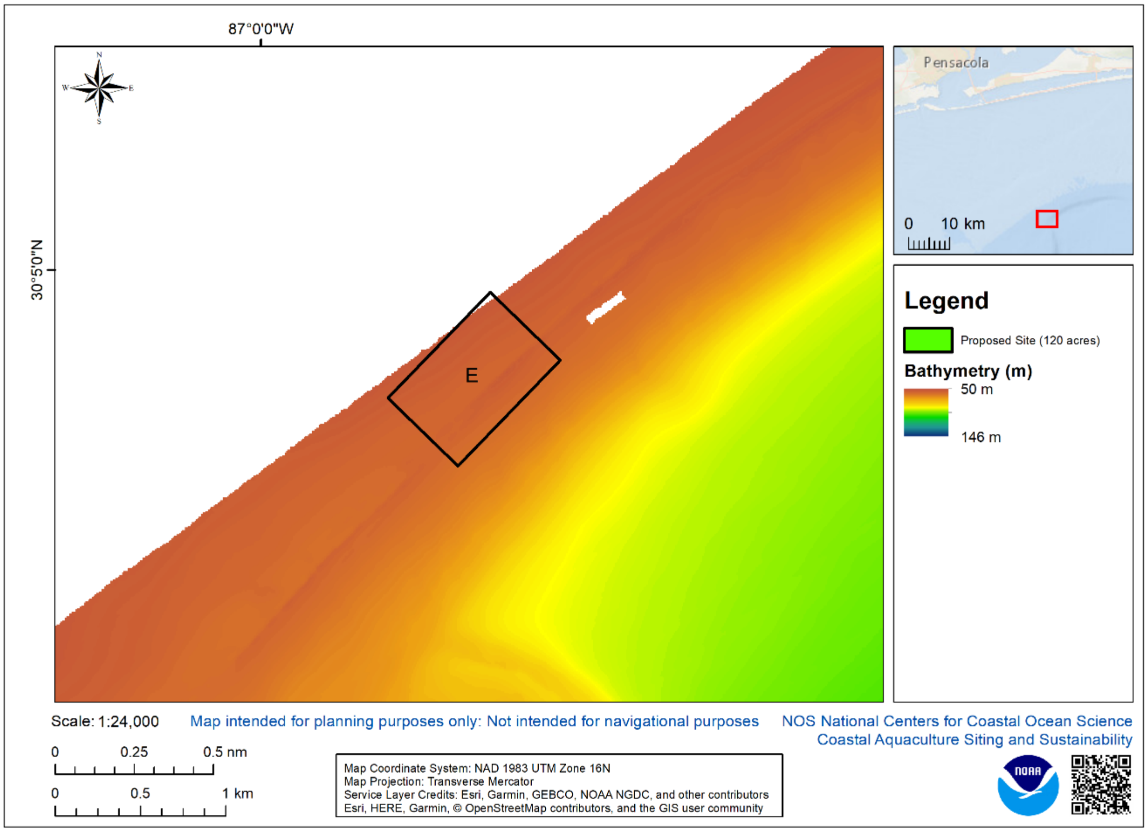


Figure 12. Multibeam bathymetry available for proposed aquaculture site.

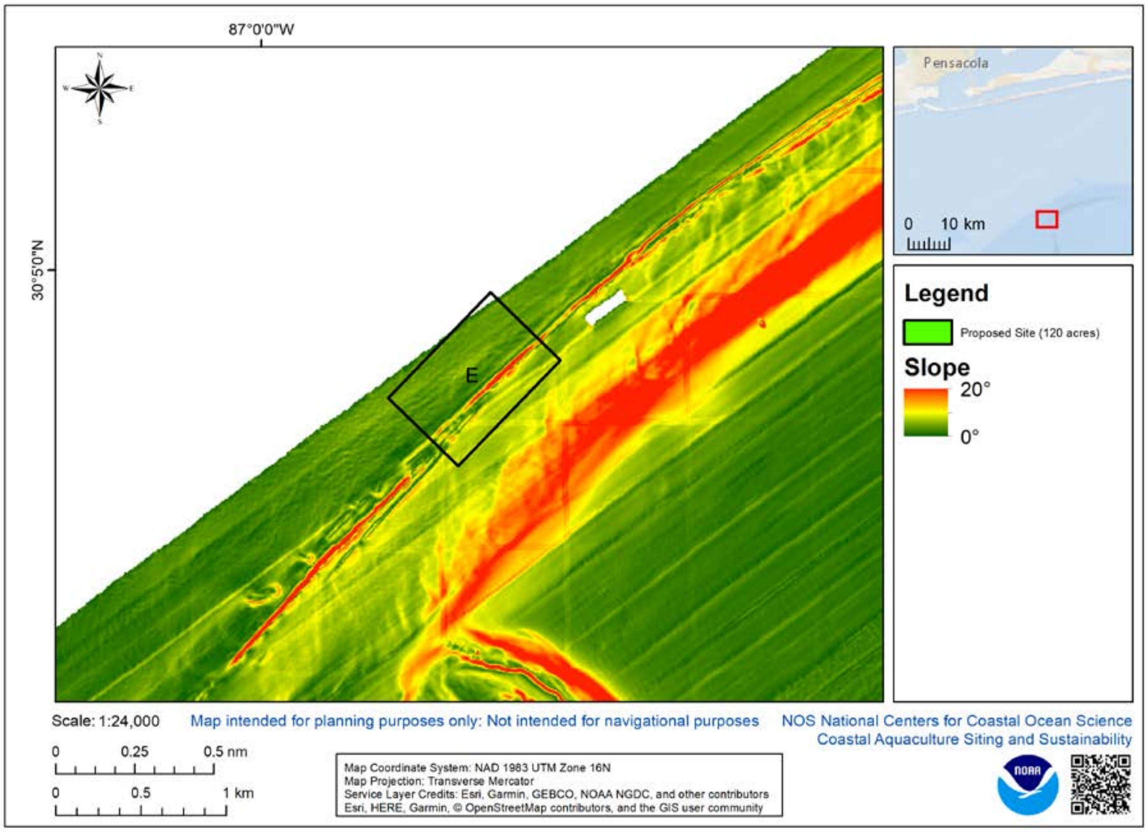


Figure 13. Slope of seafloor determined from multibeam bathymetry available for proposed aquaculture site.

Draft Site Plan:

Draft Layout, Storm Safe Submersible, (Preferred). The layout will be three, circular arrays consisting of 6, 8000m^3 cages for a total of 18 cages. The footprint of each circular array will be less than 14 acres. This circular array allows for fallowing (if necessary) by moving cage placement on the circular array or fallowing could be achieved by moving the entire circular array to another location within 120 acre permitted location.

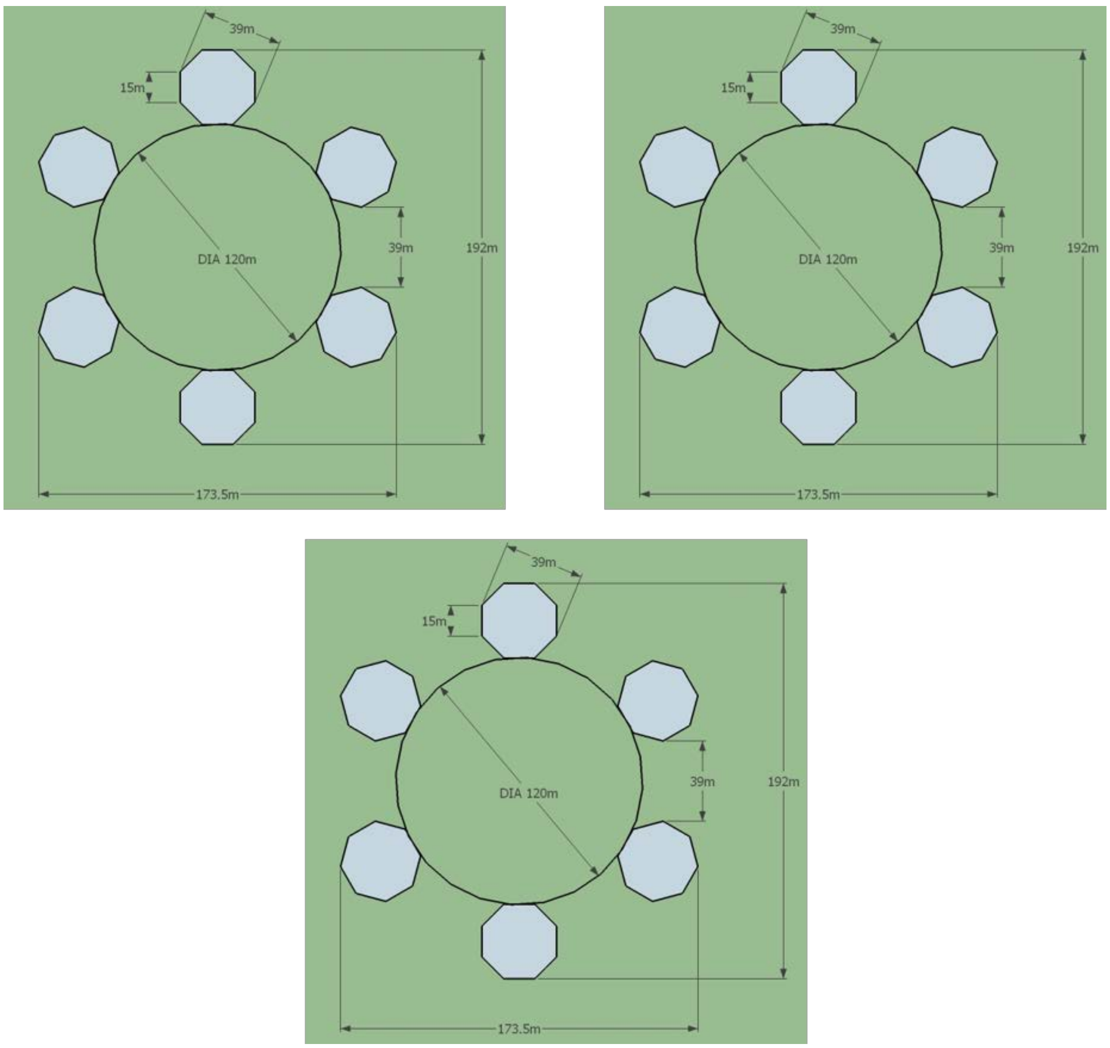


Figure 14. Diagram of Storm Safe cage arrays.

StormSafe Cage Design:
The design uses vertical spars instead of horizontal tubes that float on the surface, as with traditional net pens. StormSafe™ features 6 vertical spars, each containing 3 separate air chambers for buoyancy. Each spar houses three separate buoyancy chambers, with a network of air hoses connecting them to a manifold. The cage can be lowered to any depth in under two minutes. The vertical spar design makes it inherently stable in rough, high wave conditions. The vertical spars and overall stability also mean the unit experiences far less water resistance than typical cages. This makes StormSafe™ exceptionally easy to anchor. The entire structure is hot dipped galvanized steel to resist rust in both salt and freshwater conditions. The sides are designed to be expandable should more volume be required. It allows for the deployment of a robust tarp that protects your fish from contaminants while also making it easier to provide clean, oxygenated water when you are in protection mode. (https://www.stormsafesubmersibles.com/)

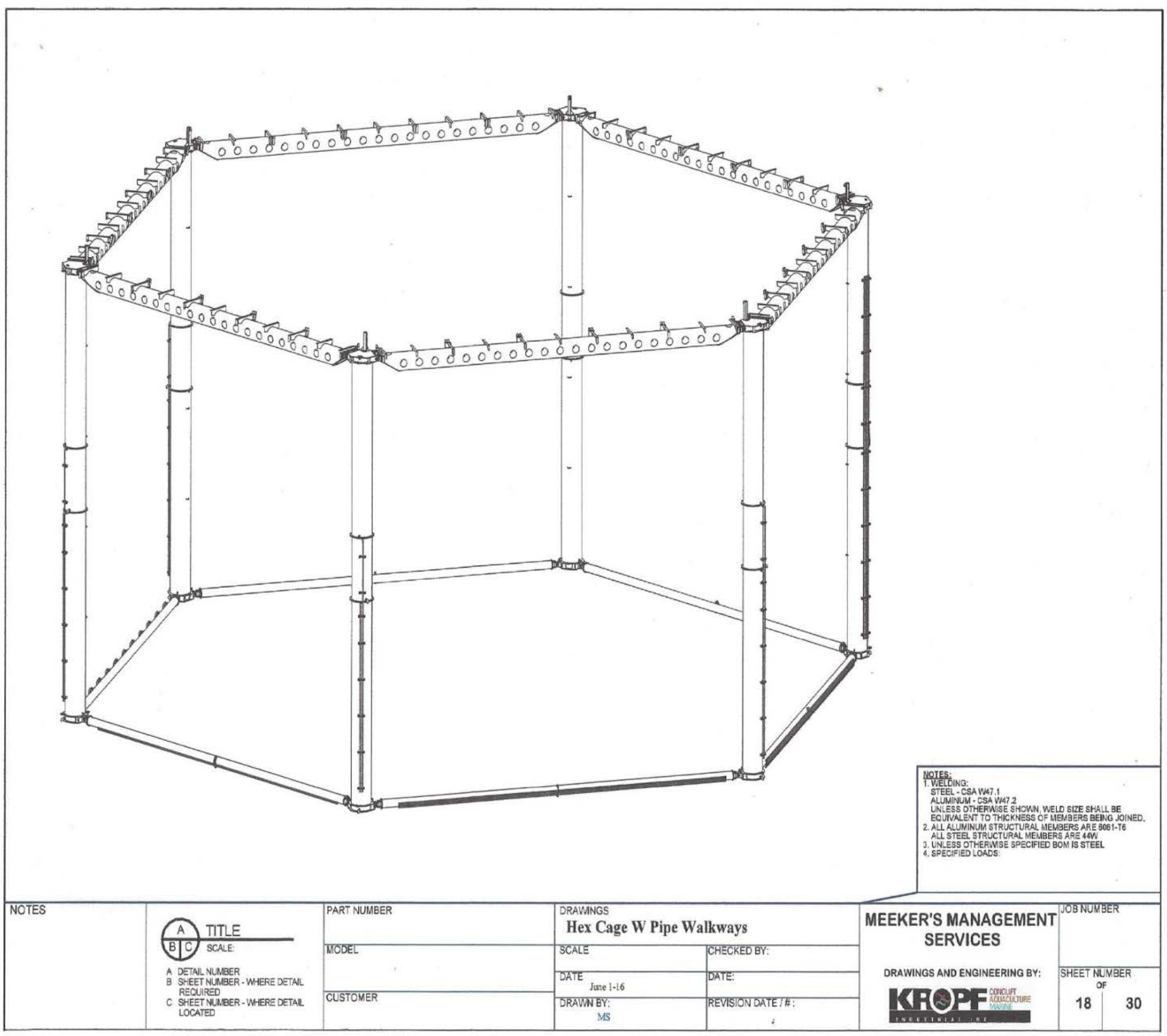


Figure 15a. Storm Safe cage design

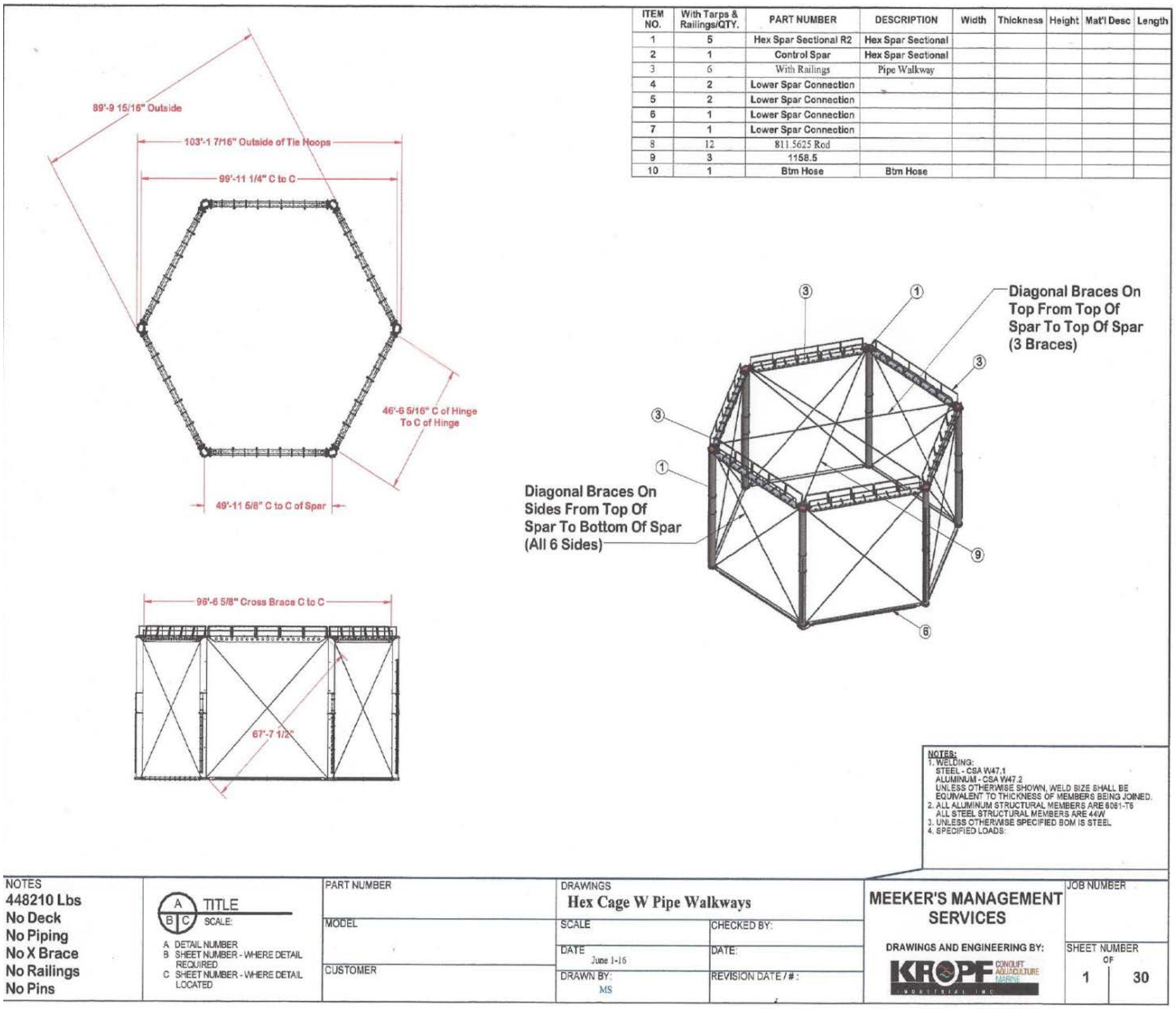


Figure 15b. Storm Safe cage design diagram 2

Design Layout and Cage Design, InnovaSea, SeaStation (Alternate)

The SeaStation design is comprised of two large steel structures. The Spar is the central pipe and controls the buoyancy and contributes to stability. The rim is the frame for the pen and provides the structure for the net and further acts to stabilize the system (https://www.innovasea.com/). The layout will be one rectangular 2X6 array covering a 93 acre footprint. Each cage is $8000m^3$.

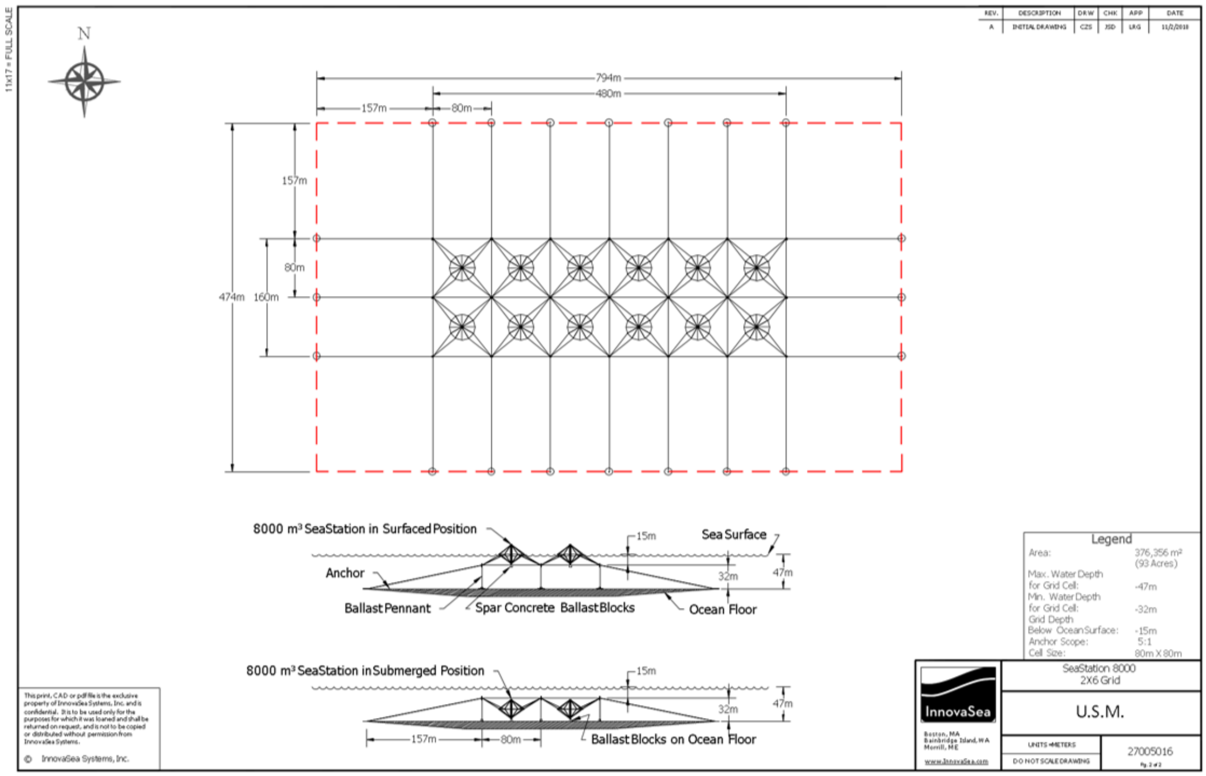


Figure 16. SeaStation cage array layout and cage information.

Mooring*:* Will be determined following bathymetric survey to accommodate structure, benthic habitat and sea climate.

Security Barge: We will comply with all vessel requirements.

Services and Supply vessels: We will comply with all vessel requirements

Lighting and signage: We will comply with all Coast Guard requirements pursuant to CG-2554.

Construction and production timeline (Timeline is based on the Storm Safe Submersible Design):

Phase 1, Year 0-1: Two cages will be moored.

Phase 2, Years 2-3: Two additional cages will be moored for a total of 4 cages.

Phase 3, Years 3-5: Eight additional cages will be moored for a total of 12 cages

Phase 4, Years 8-10: One complete circle array of six cages will be moored to bring the total to 18 cages.

Appendix B:

Manna Fish Farms – Department of Defense Response Letter 2-14-19

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
3500 DEFENSE PENTAGON
WASHINGTON, DC 20301-3500

SUSTAINMENT

February 14, 2019

Ken Riley
National Oceanic Atmospheric Administration
101 Pivers Island Rd
Beaufort, NC 28516

Dear Dr. Riley,

As requested, the Military Aviation and Installation Assurance Siting Clearinghouse coordinated within DoD an informal review of the Manna Fish Farm Project. The results of our review indicated that the water resource project located in Gulf of Mexico, as proposed, will have minimal impact on military operations conducted in the area. The Department of Navy provided the following response:

The Department of Navy does not anticipate a conflict at the proposed location but requests NOAA's continued coordination with DoD as the project progresses. One particular aspect of interest is more detail on maintenance/ship traffic related to the project. To discuss this with the US Navy, please contact Mr. Matthew Senska at matthew.senska@navy.mil.

Thank you for working with us to preserve our military's operational, training, and testing capabilities. 2018-12-WR-NOA-08 . If you have any questions, please contact me at steven.j.sample4.civ@mail.mil or at 703-571-0076.

Sincerely,

Steven J. Sample
Deputy Director
Military Aviation and Installation
Assurance Siting Clearinghouse

Appendix C:

1st Baseline Environmental Survey Plan (2019)

Multibeam and Sidescan Survey plans and specifications

Proposed Survey dates 8th April to 30th April 2019

Location

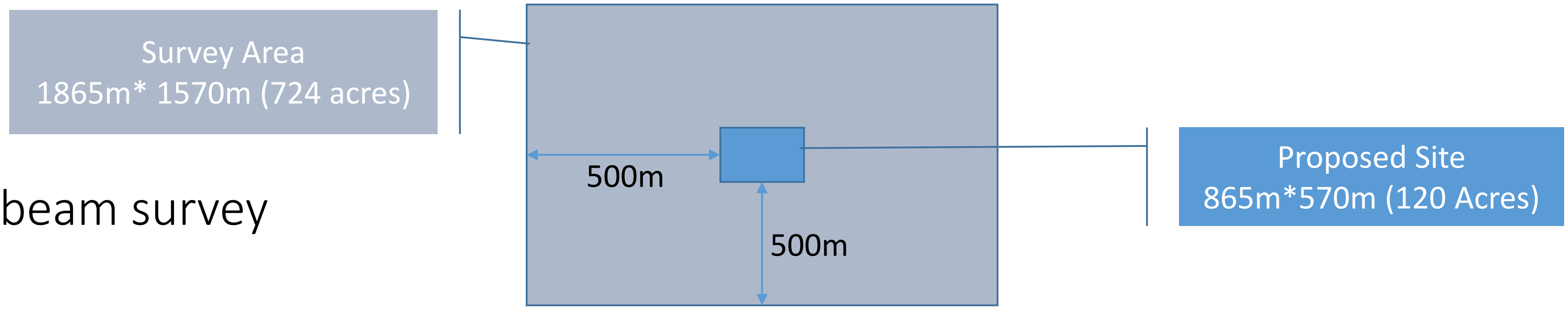
- Following coordinates in NAD 83 datum are taken from the preapplication Appendix B for **site E**

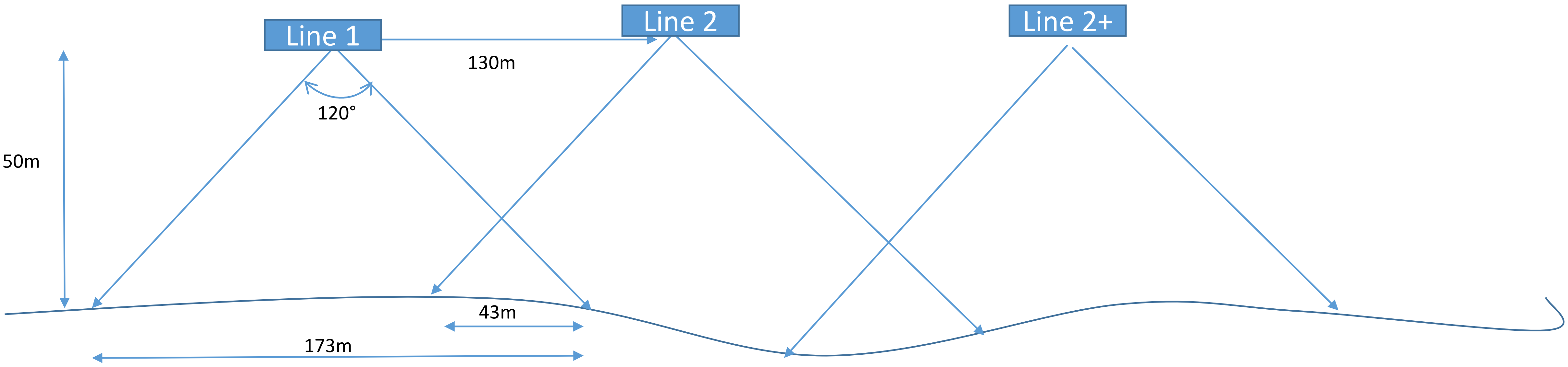
E	-86.988	30.07297
E	-86.9923	30.07656
E	-86.9861	30.08215
E	-86.9818	30.07856

Multibeam

- System used EM2040C
  - Frequency used 300Khz
  - Beam width is approximately 1.5° * 1.5°
  - Line planed to get 150% coverage of the survey area, this is equivalent of 25% overlap between adjacent survey lines (please see figure on next slide)
  - attached (MF_Fin_fish_NS.lnw) is the line plan for the Hypack project

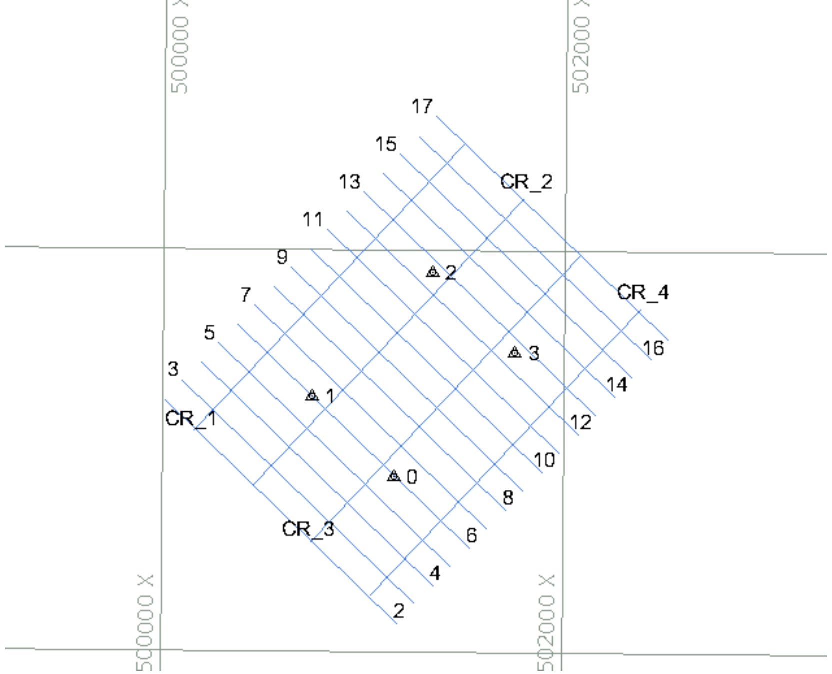
Multibeam survey plan





16 survey lines +
4 Cross lines

Multibeam survey plan



Multibeam calibration (patch test)

Ideally the patch test should be performed at the depths comparable to the actual survey area. An attempt will be made to perform patch test on the slopes (20degrees from the reported slopes) near the proposed site. If this is not achieved, then a patch test will be performed at the entrance of the Pensacola Bay.

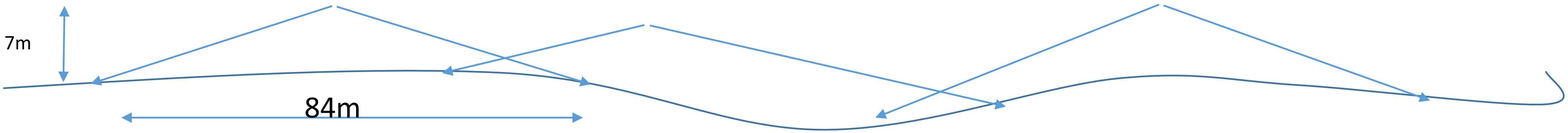
Data collected in SIS 4

1) Multibeam data in *.all
2) Motion and position data from POS MV OceanMaster (data saved for post processing)
3) Sound Velocity casts

Line plan and navigation using Hypack.

Sidescan Sonar

- Sidescan Edgetech 2205 series mounted on AUV IVER 3
- Frequency 600KHz
- Fly height 15% of water depth or less (7m above seafloor)
- Swath set to the 12 times fly height (total 84m in one pass)
- Planned to achieve 150 % coverage over the area.
- Automatic line plan done using IVER 3 control software
- Data in .jsf format, Navigation using INS onboard IVER 3



Sub-bottom profiler

- Chirp 2 to 16kHz sub-bottom
- Expected penetration of close to 10m in a sandy bottom
- Line spacing at 50m
- Pulse-length adjusted to achieve optimal penetration and resolution
- Towed behind the boat at 3knot speed.
- File format .SEGY

Magnetometer

- Towed 7m above the bottom
- Simultaneous operation with Sub-bottom (Line spacing 50m)
- File Format .HSX and .RAW

Appendix D:

1st Baseline Environmental Survey Report (2019)

Archaeological Assessment,
Site E Proposed Aquaculture Development Area
Block 896, Pensacola Area
Gulf of Mexico

Report submitted to

Thad Cochran Marine Aquaculture Center

University of Southern Mississippi
Ocean Springs, Mississippi

by
P&C Scientific, LLC
Houston, Texas

Project No. PC 2019-0002_USM_GOM

REVEALING THE PAST

P&C SCIENTIFIC

DOCUMENTING THE PRESENT

2528 Bering Dr
Houston, Texas 77057
713.201.2663

28 June 2019 | Project No.: PC 2019-0002_USM_GOM

Kelly Lucas, Ph.D.
Director
Thad Cochran Marine Aquaculture Center
School of Ocean Science and Engineering
University of Southern Mississippi

Attention: Dr. Lucas

Archaeological Assessment,
Site E Proposed Aquaculture Development Area,
Block 896, Pensacola Area, Gulf of Mexico

P&C Scientific, LLC (P&C) is pleased to submit the following report to the Thad Cochran Marine Aquaculture Center (TCMAC) at the University of Southern Mississippi for the archaeological assessment of marine geophysical data for Aquaculture Site E development area, Federal Lease Block 896, Pensacola Protraction Area, Gulf of Mexico. This archaeological assessment is based on high-resolution data collected by the University of Southern Mississippi. It satisfies the guidelines for assessing potential cultural resources in the Pensacola Area.

This report complies with current the National Oceanic and Atmospheric Administration (NOAA) Fisheries and Environmental Protection Agency (EPA) Baseline Environmental Survey Guidance and Procedures for Marine Aquaculture Activities in U.S. Federal Waters of the Gulf of Mexico, October 24, 2016.

The work performed on this project is in accordance with our proposal dated March 14, 2019 and authorized by University of Southern Mississippi Purchase Order No. 33260. We appreciate the opportunity to be of service to Thad Cochran Marine Aquaculture Center on this project and look forward to working with you on future projects.

Sincerely,

Daniel J. Warren
Marine Archaeology Principal Investigator/President
P&C Scientific, LLC

Distribution: Dr. Kelly Lucas and Dr. Anand Hiroji, University of Southern Mississippi (DRAFT)

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EXECUTIVE SUMMARY

- Thad Cochran Marine Aquaculture Center at the University of Southern Mississippi contracted P&C Scientific, LLC to perform an Archaeological Assessment for the Site E Proposed Aquaculture Development Area in Block 896, Pensacola Area, Gulf of Mexico.

- This assessment is based on the interpretation of geophysical data collected by the University of Southern Mississippi's Hydrographic Science Program on April 12, May 21-23, and May 28, 2019

- Multibeam echosounder, sidescan sonar, magnetometer, and subbottom profiler data were collected and reviewed for this assessment.

- Seafloor topography within the study area is smooth and sloping to the southeast. A small ridge runs across a portion of the study areas in a northeast/southwest direction.

- The ridge appears to be composed of some exposed hard bottom areas that could support biological communities.

- Water depths within the study area range from 50 to 76 meters Below Sea Level (BSL).

- There is no known infrastructure within the project area.

- Within the study area, there are six (6) unidentified sonar contacts and nine (9) unidentified magnetic anomalies.

- None of the sonar contacts or magnetic anomalies are recommended for avoidance based on archaeological potential.

- No relict landforms indicative of those associated with prehistoric human occupation sites were observed in the subbottom profiler data from within the study area.

- Based on the assessment of the available geophysical data, the Area of Potential Effect for the Site E Proposed Aquaculture Development Area appears clear of archaeological resources.

1 ARCHAEOLOGICAL ASSESSMENT

1.1 INTRODUCTION

Thad Cochran Marine Aquaculture Center (TCMAC) at the University of Southern Mississippi contracted P&C Scientific, LLC (P&C) to perform an Archaeological Assessment for Site E Proposed Aquaculture Development Area. The survey area is an 1800-meter x 1500-meter box located approximately 48 kilometers (30 mi) southeast of Perdido Key, Florida (Figure 1). The survey area is within Federal Lease Block 896, Pensacola Area, Gulf of Mexico. This assessment is based on the interpretation of the geophysical data collected the University of Southern Mississippi's Hydrographic Science Program.

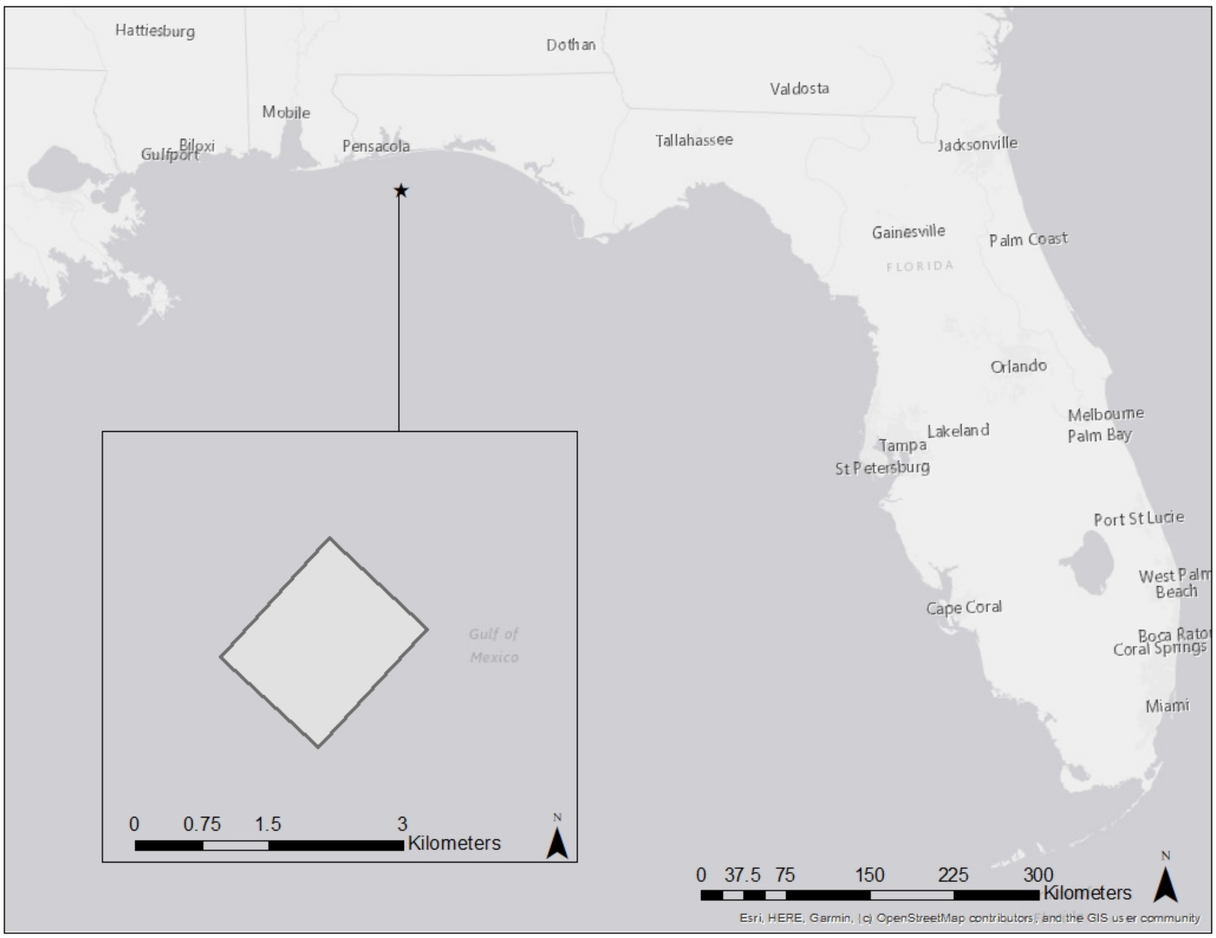

Figure 1. Location Map showing the Site E Proposed Aquaculture Development Area. Image by Anand Hiroji, University of Southern Mississippi.

The purpose of this assessment is to identify potential submerged archaeological resources that could be impacted by aquaculture development activities. The survey fieldwork and this report comply with the National Oceanic and Atmospheric Administration (NOAA) Fisheries and Environmental Protection Agency (EPA) Baseline

Environmental Survey Guidance and Procedures for Marine Aquaculture Activities in U.S. Federal Waters of the Gulf of Mexico, October 24, 2016. All pertinent geophysical data has been reviewed by a qualified marine archaeologist who meets or exceeds the requirements established by the United States Department of Interior.

University of Southern Mississippi's Hydrographic Science Program collected the geophysical data for the survey. The geophysical data was collected aboard the R/V *LeMoyne* on April 12, May 21-23, and May 28, 2019. The vessel maintained a speed between 4-6 kts while collecting sub-bottom data. For magnetometer data collection, vessel speed was approximately 1.5-2kts due to limited cable and the requirement that the magnetometer be within 6 meters of the seafloor. The Iver3 AUV speed was set to 2 to 2.25 kts for sidescan data collection. Sea conditions during data acquisition were 1 to 5 feet, with winds between 5 to 13 knots, allowing for good quality data.

Geophysical instruments utilized during the survey consisted of the Kongsberg EM 2040C Multibeam Echosounder (300-kHz Operational Frequency with a 65-degree swath width), Iver3 Autonomous Underwater Vehicle (AUV) equipped with an Edgete4ch 2050 Sidescan Sonar (590 kHz), Edgetech 3100P Chirp subbottom Profiler (2-16 kHz), and a Geometrics G-882 Cesium Magnetometer. Surface positioning of the R/V *LeMoyne* was accomplished using an Applanix POS MV inertial aided GNSS system was used as a primary positioning system. Realtime accuracy in position was between 0.1 to 0.3m. A CNAV DGPS positioning system was used as a secondary GNSS positioning system. The DGPS corrections received via geostationary satellites were transmitted to the Primary POS MV system in Realtime. Positioning of the towed sensors and the IVER3 AUV was accomplished by applying cable layback values in Realtime or during post processing of the data. Assessment of the data was carried out using Cheseapeake's SonarWiz 7 software and Blue Marble's GlobalMapper 20.1 software.

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Due to time and equipment constraints, separate survey grids were used for the multibeam and side scan, subbottom profiler, and magnetometer systems The sidescan sonar grid, surveyed by the Iver3 AUV, consisted of 10 lines surveyed in a roughly northeast to southwest direction with the AUV approximately 10 to 11 meters above the seafloor. Line spacing on the initial AUV deployment was 133 meters (436 ft) and at 110 meters (360 ft) on the second deployment. The total side scan sonar swath width for each line was approximately 202 meters (663 ft) or 101 meters (331 ft) per channel.

The multibeam echosounder survey grid consisted of 10 lines surveyed in a northeast to southwest direction. Line spacing for the multibeam echosounder survey was 133 meters (436 ft). The multibeam echosounders total swath width was 130 degrees or 65 degrees per channel.

The subbottom profiler grid consisted of 24 total lines. The primary grid consisted of 17 lines surveyed approximately northeast to southwest at 100 m (328 ft) line spacing and 7 crosslines at 300m (984 ft) lines spacing surveyed in a roughly northwest to southeast direction. The subbottom was deployed as a towed system and was towed approximately 20 meters above the seafloor.

The magnetometer grid consisted of 31 lines. The magnetometer lines were surveyed at 50 meters (164 ft) line spacing in a roughly northeast to southwest direction. The magnetometer altitude was maintained as close to 6 meters (20 ft) above the seafloor as possible.

Navigation fixes (event marks) were recorded continuously and annotated at 152-meter (500 ft) intervals along all survey lines. The survey grid was designed to provide a 100% seafloor coverage for the sidescan sonar (200% overlapping coverage) and multibeam systems and representative sampling with the subbottom profiler, and magnetometer systems.

Unidentified Sidescan Sonar Contact and Magnetic Anomaly Reports with data reproductions are provided in Appendix A. Appendix B contains the descriptions of survey equipment settings for data acquisition, vessel setback information, a listing of all field personnel involved in this project, and a copy of the survey logs.

The geodetic datum used to generate the study maps is the World Geodetic System 84 (WGS 84) The study maps are referenced to WGS 84 UTM 16 North meters. All coordinates given are presented in this projection on the study maps and referenced within this report. All grid units presented on the study maps, as well as scales and measurements are in meters.

1.2 PREHISTORIC BACKGROUND

Between 60,000 and 50,000 years ago and between 24,000 and 20,000 years ago, during the Wisconsin Period, advancing continental glaciers covered much of the North American Continent. These expansive ice sheets trapped large amounts of water as polar ice. This resulted in the Earth's sea levels dropping by nearly 400 feet planet wide (Fisk and McFarlan, 1955). As the seas and oceans receded, large expanses of land were exposed. In some areas, these newly uncovered areas created land bridges connecting the continents. Humans and other animals used these bridges to access new lands. One such land bridge, exposed in the Bering Strait, connected what is now Siberia to Alaska. Many western scientists believe the land bridge was a major human migration route between Asia and North America. In the Gulf of Mexico region, the seas receded to nearly the edge of the continental shelf (Fisk, 1944). Once exposed the new areas of land were quickly overgrown by vegetation. As early as 20,000 to 12,000 years ago vegetation on the land uncovered along the continental shelf was such that it supported vast faunal life and could have easily supported human occupation. The areas exposed by the falling sea levels also became subject to natural erosion processes from wind and water. Melting glaciers cut new rivers and streams into these new regions. Archaeological sites of early native cultural groups are often found in association with these waterways on landforms such as river or coastal terraces, point bars, or near the mouths of river valleys (Pearson, *et*. *al*. 1986). Roughly 17,000 years ago, the Earth's climate began to warm, triggering a worldwide glacial melt and sea levels began to rise. As the seas rose many of the prehistoric human occupation sites along the continental shelfs were buried by sediments as water covered them. These sediments may have acted as a protective layer, shielding the sites from the erosional impacts of the Holocene Transgression (Belknap, 1983: 382-387).

1.3 PREHISTORIC POTENTIAL

Much of the Northern Gulf of Mexico continental shelf has been covered by extensive sediment deposits associated with the Holocene sea level rise during the past 10,000 years. Within the study area, Holocene sediments are thin to non-existent. Much of the area is comprised of homogeneous sand. Current sea level curve estimates indicate rising sea level inundated 13,000 to 15,000 years ago. Prehistoric Human Cultural Groups, often referred to as Pre-Paleoindians, could have used the area during the period of terrestrial exposure.

1.4 HISTORIC BACKGROUND

The European maritime history of the Gulf of Mexico extends back to the early Spanish incursions in the 16th century. One of the earliest recorded Spanish explorations was the 1526-1528 expedition lead by Pánfilo de Narváez. After exploring Florida's interior, Narváez and his men attempted to reach Mexico on sailing barges they had constructed, only to have all the vessels wreck along the Texas Coast. Of the nearly 400 conquistadors in the expedition, only four survivors ever reached Mexico (Pearson et al., 1989).

From the 16th to 19th centuries Spanish treasure fleets regularly sailed through Gulf waters transporting raw materials and treasure from Mexico back to Spain. Many of these vessels met their end on the Texas, Louisiana and Florida coasts. Three vessels from the 1554 fleet, *Santa María de Yciar*, *Espíritu Santo*, and *San Estebán* were wrecked in a violent storm off Padre Island. The Texas Antiquities Committee subsequently located and excavated *San Estebán* between 1972 and 1975 (Arnold and Weddle, 1978; Keith, 1988).

The Spanish were not the only explorers and settlers interested in the Gulf of Mexico. From the 17th to the 18th century the French worked to establish a foothold in the region. Explorers, such as La Salle, Pierre le Moyne, Sieur de Iberville, and Jean Baptiste le Moyne, Sieur de Bienville led the way as new French colonies were established at Biloxi Bay, Mobile Bay, and New Orleans (Pearson et al., 1989). By 1762, however, the French ceded the Louisiana Territory to Spain, increasing Spanish interests on the northern Gulf coast. As Spanish shipping in the Northern Gulf increased so did shipwrecks. One wreck that has been found and documented by archaeologists is the *El Nuevo Constante*. *El Nuevo Constante* was a Spanish merchant vessel referred to as a frigate in contemporary documents. It was wrecked along the Louisiana coast in 1766 with another vessel, *Corazón de Jesús y Santa Bárbara,* which has never been located (Pearson et al., 1989; and Pearson and Hoffman, 1995).

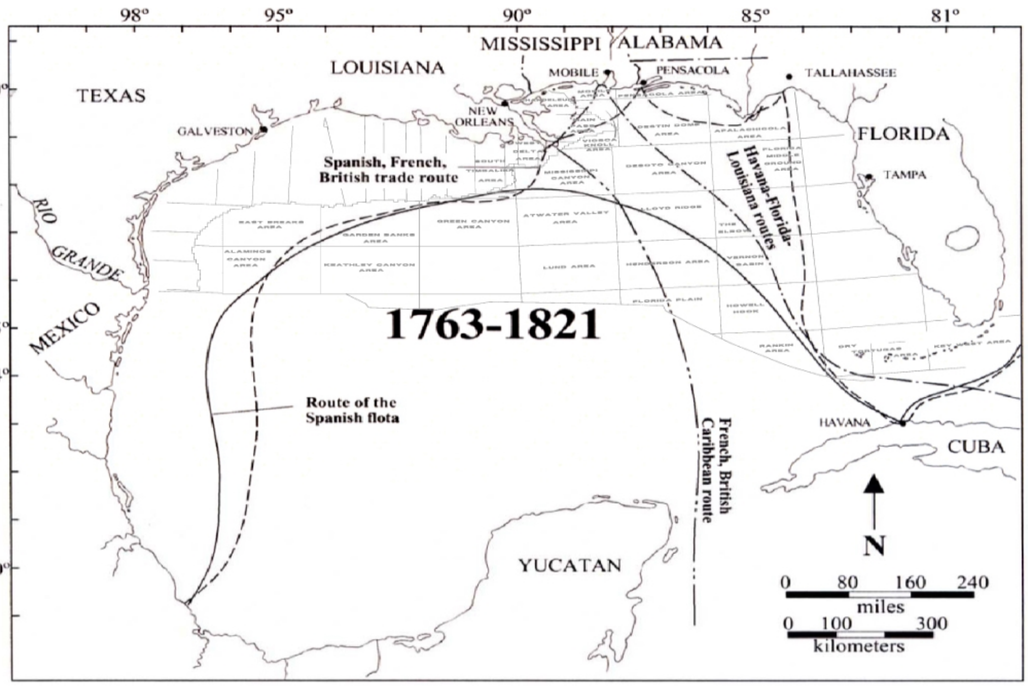

Figure 2. Shipping routes in the Gulf of Mexico, 1763–1821 (Based on Pearson et al., 2003).

When Spain secretly returned the Louisiana territory to France in 1800, United States President Thomas Jefferson, fearing control of the lower Mississippi by the French, sent Robert Livingston to Paris to negotiate with the French. In April 1803, Livingston negotiated the sale of the Louisiana Territory to the U.S. expanding the territorial boundaries of the United States to the Pacific Ocean. The vague boundaries of the territory gave the U.S. a strong claim to Texas and "West Florida." From 1810 to 1813, the American government laid claim to the Florida parishes of Louisiana, the coast of Mississippi, Alabama, and West Florida (Pearson et al., 1989).

During the early part of the 19th century most waterborne commerce in the central part of the Gulf was centered on New Orleans. With the introduction of steam vessels, maritime commerce in the Gulf of Mexico increased dramatically. By Civil War, major steamship lines were running vessels out of New Orleans (Pearson et al., 1989). The growth in maritime activity led to a proportionate increase in ship losses and several examples from that period have been documented. In 1997 and 1999, MMS Archaeologists identified the nineteenth century steamship *Josephine*, which sank off the coast of Mississippi in 1881 (Irion and Ball, 2001).

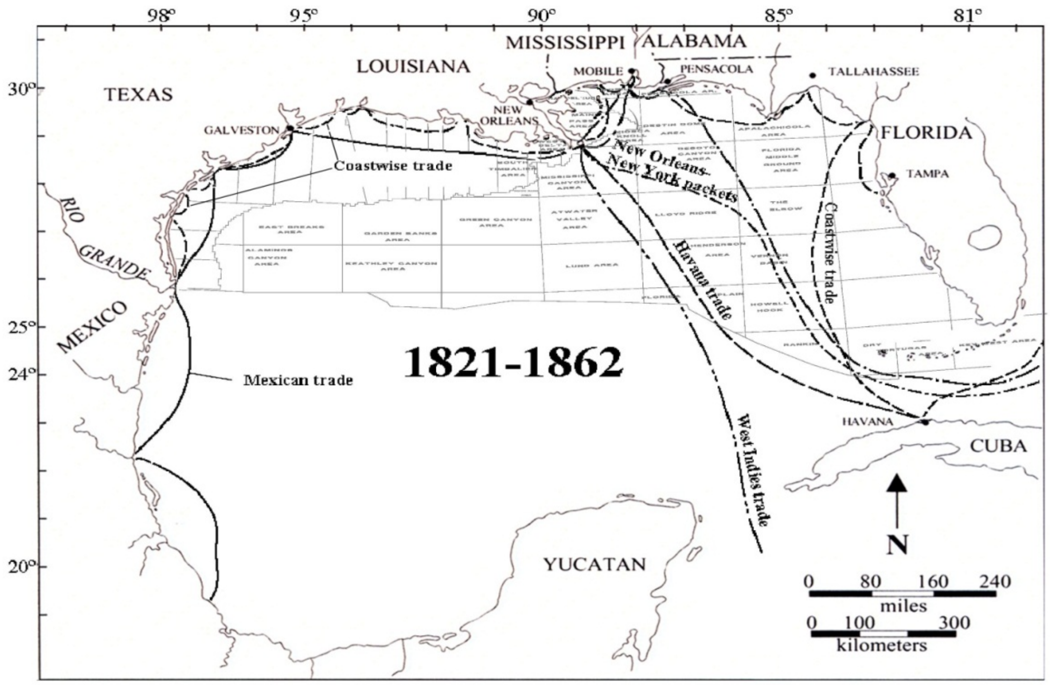

Figure 3. Shipping routes in the Gulf of Mexico, 1821–1862 (Based on Pearson et al., 2003).

During the Civil War, U.S. President Abraham Lincoln proclaimed a blockade of Southern ports as part of the General Winfield Scott's Anaconda Plan. As a result, Union blockaders, Confederate blockade-runners, and Confederate "commerce raiders" were soon plying the Gulf's waters. By January 1862, the converted mail steamer CSS *Sumter* had captured or destroyed eighteen U.S. merchant ships on her cruise from New Orleans to Gibraltar. The CSS *Alabama* sank the steamer USS *Hatteras* off the coast of Galveston, Texas in the summer of 1862. CSS *Alabama* sank a record seventy-six vessels before being sunk herself off the coast of Cherbourg, France by the USS *Kearsarge* (Watts, 1988).

After the Civil War, steamships began to increase in frequency and throughout the last half of the nineteenth century they plied the Gulf of Mexico along with more traditional sailing craft such as schooners, clippers, and "New Orleans" luggers. The discovery and production of oil in Louisiana and Texas at the dawn of the 20th century saw the beginning decline of steam propulsion. By the second decade of the 20th century, steamships were replaced by vessels with diesel engines and screw propellers (Pearson et al., 1989).

By the start of World War II, steel hull ships driven by petroleum were the major carriers of goods in the Gulf of Mexico. With the entry of America into the war in 1941, Hitler ordered his U-boats into the Gulf of Mexico to attack shipping. In roughly a year, 17 U-boats sank 56 vessels and damaged 14 others with the loss of only one U-boat lost in the Gulf of Mexico (Church and Warren, 2002).

1.5 HISTORIC POTENTIAL

There is a proven and documented association between shipping routes and shipwreck locations in many areas around the globe, including the Gulf of Mexico. Traditional shipping routes passed south of the project area since mid-18th century. Later steamship navigation routes traversed the area beginning in the second decade of the 19th century (Figures 3 and 4, Pearson et al., 2003).

According to BOEM/BSEE records, one shipwreck and one possible shipwreck are listed within five nautical miles of the survey area (Table 1). One of the wrecks, *Candy Ship* is listed as a freighter and is of unknown age. According to the BOEM/BSEE shipwreck database the possible unknown shipwreck may be the same target as *Candy Ship*, based on the proximity of the coordinates.

Table 1. Shipwrecks Reported within 5 Nautical Miles of the Survey Area

Vessel Name	Date Built	Date of Loss	Location Reliability*
Candy Ship	Unknown	Unknown	2
Possible Shipwreck	Unknown	Unknown	4

**Location reliability based on scale 1 to 4, 1 being reliable, and 4 being unreliable*

Pearson's 2003 study lists the Pensacola Area as having a moderate potential for undocumented shipwrecks and a low potential for shipwreck preservation. Regional studies indicate the sediment type within the study area is composed mostly of sand (USDI MMS, 1978).

1.6 ASSESSMENT OF DATA

1.6.1 Multibeam Echosounder Record

Multibeam echosounder data were used to determine water depths in the study area. The bathymetry data is depicted in 2 meters (7 ft) contour intervals and referenced as Below Sea Level (BSL) on the study maps. Water depth values within the study area range from between 50 meters (164 ft) to 76 meters (249 ft) BSL. The bathymetric data depicts a relatively even seafloor sloping to the southeast. A small seafloor ridge runs east to west across a portion of the study areas southeastern extent.

1.6.2 Subbottom Profiler Record

The subbottom profiler data (Figure 4) was examined for relic landforms that are often associated with prehistoric human occupation areas. The subbottom profiler provided subsurface imagery to a depth of 60 meters (197 ft) below the seafloor. The shallow subsurface stratigraphy recorded in the subbottom data is indicative of a mainly sand substrate.

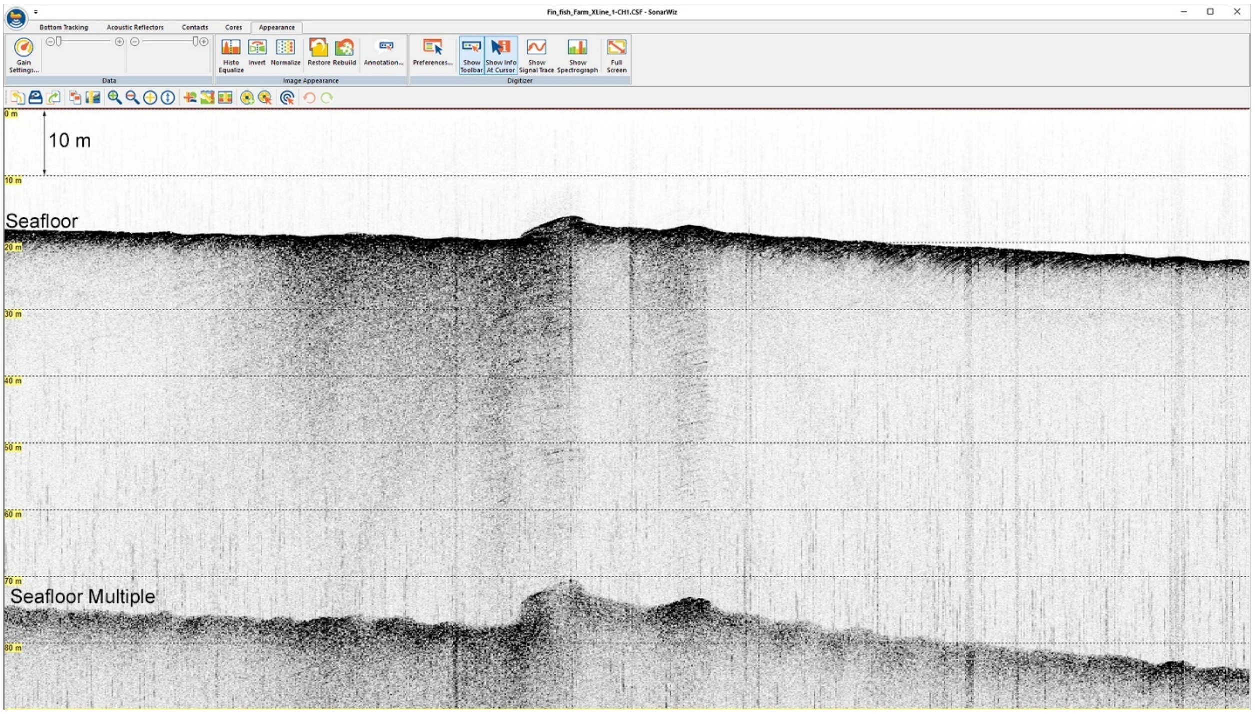

Figure 4. Subbottom profiler record of xline 1 within the study area. Record shows quality and depth of penetration of the subbottom system.

There are three main subsurface geological features visible in the subbottom data; migrating sand waves, a possible localized fluvial system, and a dome like structure. Most of the survey area is covered by migratory sand waves as shown in Figure 5. The dipping effect reflects the migration and possibly a presence of mixed sediments. All the deposits appear to be reworked sediments.

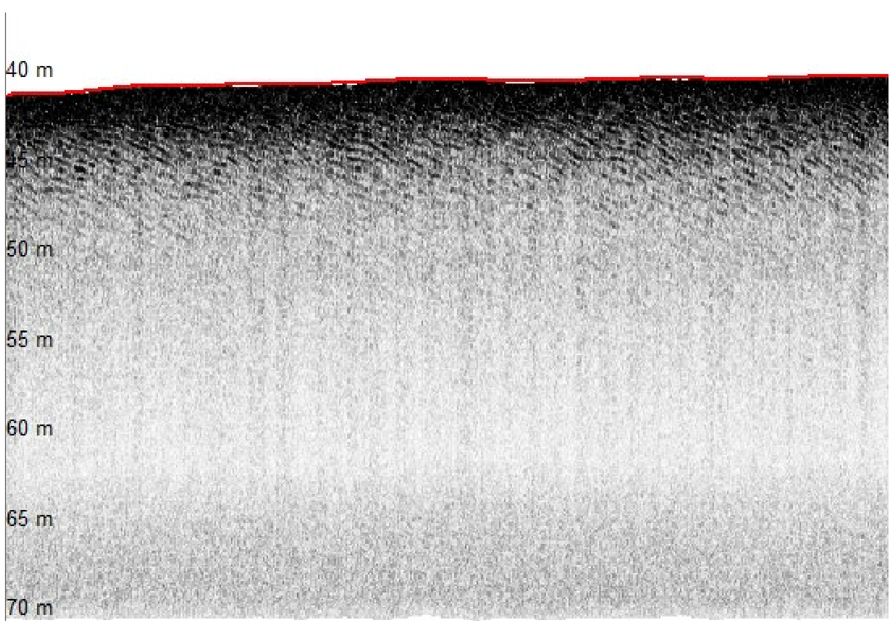

Figure 5. Migratory sand waves as seen in subbottom data.

Localized stratigraphy is present at the south edge of the survey area to the depth of more than 10 meters (33 ft) below seafloor. This may be a possible fluvial system, but it is very localized and is not indicative of a complete well-developed system (Figure 6).

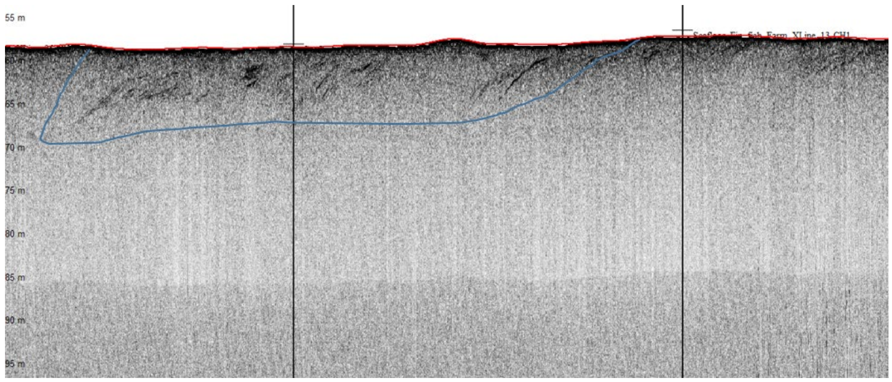

Figure 6. Possible localized fluvial system as seen in subbottom data

A dome like structure is visible at all cross lines just below the small surficial ridge, possibly a paleo-shoreline. This ridge, also visible in multibeam and sidescan data, has been identified as a possible hard bottom area. This dome extends to more than 60 meters (197 feet) at the South West end of the survey area (Figures 7 and 8). This dome has a similar density distribution that of other salt domes discovered in the similar geographical area of De Soto Canyon (Harbison, 1968). This indicates that it could be a possible salt and/or gas dome.

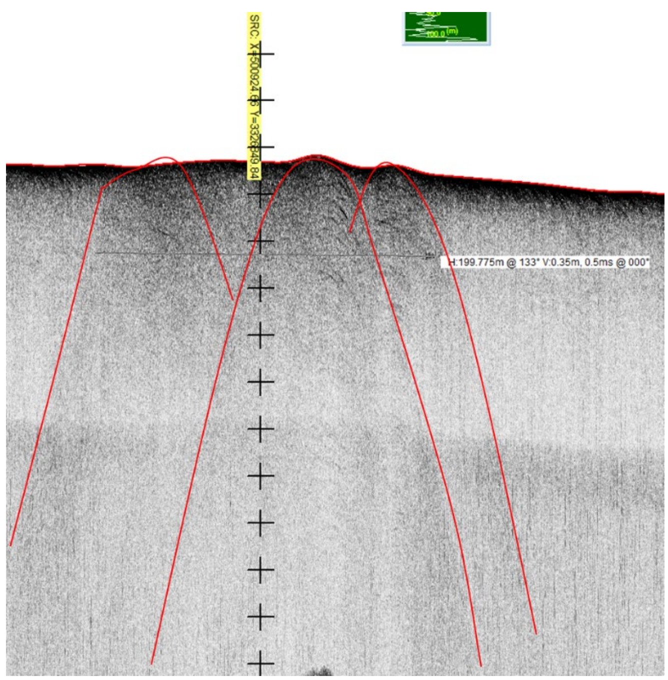

Figure 7. A section of the Crossline No. 7 showing three overlapping domes

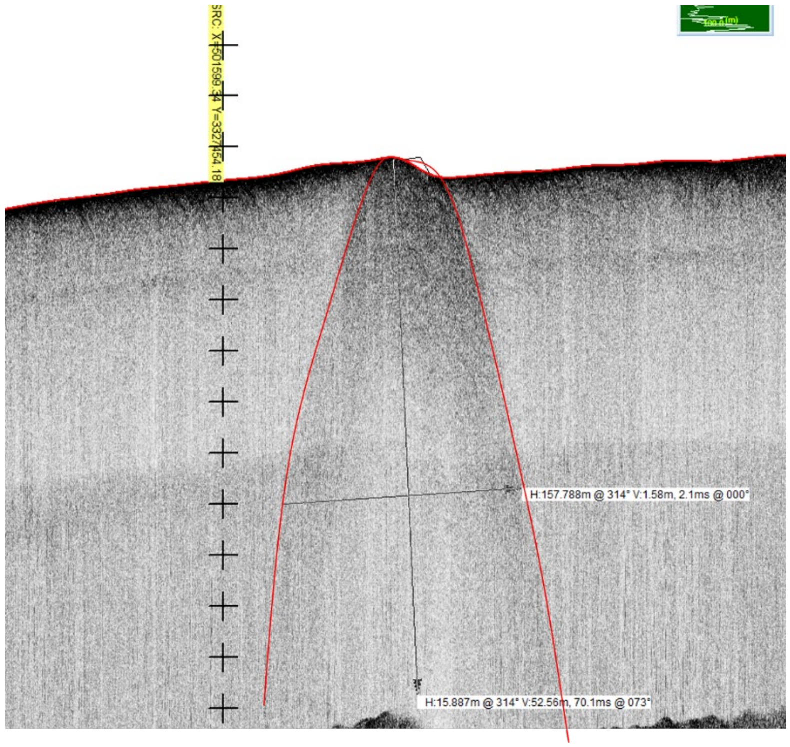

Figure 8. A section of the Crossline No. 25 showing three overlapping domes

Review of the subbottom data did not identify any relict landforms within the study area. No specific landforms such as natural levees, point bars, channel features, or flood plains were found that could have supported prehistoric occupation sites.

1.6.3 Magnetometer Record

The is no known infrastructure within the study area. The magnetometer recorded nine (9) unidentified magnetic anomalies within the study area (Appendix A). The unidentified magnetic anomalies have amplitudes ranging from 4.30 to 26.34 gammas with durations between 28.64 meters (94 ft) and 82.5 meters (271 ft) (Table 2). One unknown magnetic anomaly, No. 6 (Table 2), is associated with Sonar Contact No. 1. Unknown magnetic anomaly No. 6 is a small source anomaly that is either result of seafloor geology or small buried ferrous debris.

All the magnetic anomalies are small as far as amplitudes and durations which is suggestive of isolated point source targets. The magnetic anomalies do not exhibit amplitude/duration characteristics or clustering that would be typically indicative of a submerged archaeological resource. The nine unidentified magnetic anomalies are interpreted as likely being modern debris associated with shipping, fishing, or other anthropogenic activities in the study area.

A magnetic anomaly report with data reproductions of each anomaly is provided in Appendix A. The unidentified magnetic anomalies are also depicted on the provided study maps.

Table 2. Unidentified Magnetic Anomalies in Study Area

UNIDENTIFIED MAGNETIC ANOMALY TABLE										
Ref. No.	Area	Block	Line No.	Sensor Height (m)	Shot Point	Amp. (γ)	Signature Duration (m)	WGS84 UTM (m)		Avoidance Criteria (ft)
								Easting (x)	Northing (y)	
1	PE	940	Maggy_XYZ_1	7	0.25	4.47	28.64	500782.110	3326611.340	None
2	PE	896	Maggy_XYZ_1	7	12	26.34	52.53	501960.690	3327900.440	None
3	PE	896	Maggy_XYZ_1	6	6	12.41	58.18	501363.190	3327351.800	None
4	PE	896	Maggy_XYZ_1	7	1.5	3.99	39.18	500815.650	3326858.460	None
5	PE	896	Maggy_XYZ_1	6	2	15.88	60.78	500856.480	3326900.820	None
6	PE	896	Maggy_XYZ_1	6	7	10.60	82.15	501328.800	3327455.110	None
7	PE	896	Maggy_XYZ_1	5	10	4.30	59.78	501660.290	3327881.520	None
8	PE	896	Maggy_XYZ_1	5.5	10	19.88	59.33	501617.750	3327905.900	None
9	PE	896	Maggy_XYZ_1	14	7	4.95	36.40	500856.180	3327902.870	None

1.6.4 Side Scan Sonar Record

The sidescan sonar data shows low to moderate reflectivity throughout the study areas, with areas of higher reflectivity associates with the ridge feature that crosses a portion of the southeastern study area. Six (6) unidentified sonar contacts delineated in the sidescan sonar data covering the study area (Appendix A). The unidentified sonar contacts range in length from 2 meters (7 ft) to 7 meters (23 ft), in width from 1 meter (3 ft) to 5 meters (16 ft), and from no measurable height to 2 meters (7 ft) of seafloor relief (Table 3). One sonar contact has an associated magnetic anomaly. Unidentified Sonar Contact No. 1 is associated with Unidentified Magnetic Anomaly 6 (10.6 gammas, 82.1 m duration).

The largest unidentified sonar contacts are Nos. 3 and 4. Sonar contact No. 3 is 7 meters (23 ft) long, 5 meters (16 ft) wide, and has no measurable seafloor relief. It has no associated magnetic anomaly. The acoustic signature suggests it is a depression. Sonar Contact No. 3 is interpreted a likely seafloor impact crater, possibly an anchor strike or the remnants of a gas expulsion feature or pockmark. Sonar Contact No. 4 is 6 meters (20 ft) long, 1 meter (3 ft) wide, and has no measurable seafloor relief. It has relatively high reflectivity but has no associated magnetic anomaly. Sonar Contact No. 4 may represent modern debris or a geologic feature.

All six unidentified sonar contacts considered to be modern debris associated with shipping, fishing, artificial reef development, or are geologic in origin. Based on the review of the available geophysical data, none of the sidescan sonar contacts exhibit the shape or reflectivity characteristics typically associated with submerged archaeological resources such as shipwrecks.

Data reproductions of each unidentified sonar contact are presented in the Sonar Contact Report located in Appendix A. All unidentified sonar contacts are also depicted on the study maps.

The sidescan sonar data also depicts a small ridge that extends across the southerly portion of the study area in a northeast/southwest direction. To the northeast the ridge is approximately 125 meters (410 ft) in width, widening to roughly 250 meters (820 ft) in the southwest. This ridge may be a portion of a relict landform discussed by Gardner, et al. (2007) that is part of what he refers to as the delta b area along the northern shelf edge of De Soto Canyon.Can

The ridge appears to be composed of some exposed hard bottom areas that could support biological communities. To what extent or types of biological communities may be present in this area cannot be discerned from the current dataset.

Table 3. Unidentified Sidescan Sonar Contacts in Study Area

SONAR CONTACT TABLE										
Ref. No.	Area	Block	Mag. Assoc.	Dimensions (m)			Shape	WGS84 UTM (m)		Avoidance (m)
				Length	Width	Height		Easting (x)	Northing (y)	
1	PE	896	6	5	3	2	Irregular	501321.784	3327484.783	None
2	PE	896	None	3	1	0	Irregular	501512.057	3327058.318	None
3	PE	896	None	7	5	0	Irregular	501558.939	3326993.591	None
4	PE	896	None	6	1	0	Irregular	501360.619	3326839.078	None
5	PE	940	None	2	1	0	Irregular	500817.317	3326701.030	None
6	PE	940	None	4	2	2	Irregular	501003.489	3326376.546	None

1.7 CONCLUSIONS AND RECOMMENDATIONS

The archaeological assessment survey observed no evidence of relict landforms such as natural levees, point bars, channels, or flood plains that could have supported human occupation sites. No areas are recommended for avoidance or investigation based on the prehistoric archaeological potential.

Review of the geophysical data for the archaeological assessment documented six (6) unidentified sidescan sonar contacts and nine (9) unidentified magnetic anomalies in the study area. Both the sidescan sonar contacts and unidentified magnetic anomalies are relatively small or amplitude and do not exhibit characteristics typically associated with submerged archaeological resources such as shipwrecks. The unidentified sidescan sonar contacts and magnetic anomalies are interpreted as modern debris. They are likely associated with modern fishing, shipping, artificial reef development, or are geologic in origin. None of the unidentified side scan sonar contacts or the unidentified magnetic anomalies are recommended for avoidance or investigation based on archaeological potential. Based on the evaluation of the available geophysical data, the APE for this project appears clear of archaeological resources.

A ridge that may be part of a relict landform runs northeast to the southwest within the southerly portion the development area. The ridge appears to be composed of some exposed hard bottom areas that could support biological communities. To what extent or types of biological communities may be present in this area cannot be discerned from the current dataset.

Due to the nature of acoustic geophysical data, it is possible that archaeological remains could go undetected in the study area. If potential archaeological material such as anchors, planking ceramics or similar materials are encountered, all work should be suspended in the immediate area and EPA personnel should be notified within 48 hours so an assessment of the materials can be carried out by qualified personnel. No activities should be conducted near the area of discovery until advised by the appropriate EPA personnel.

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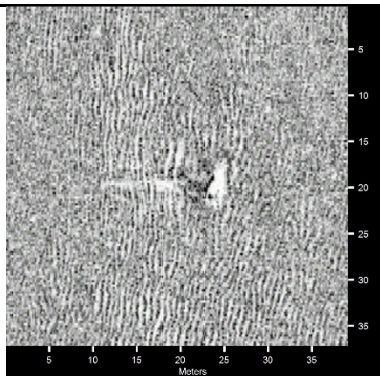
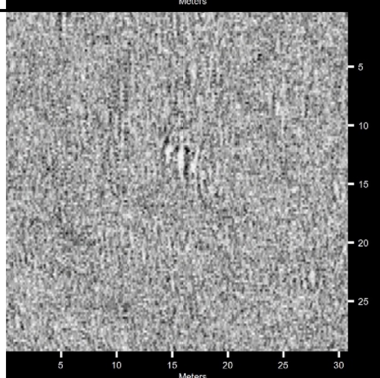
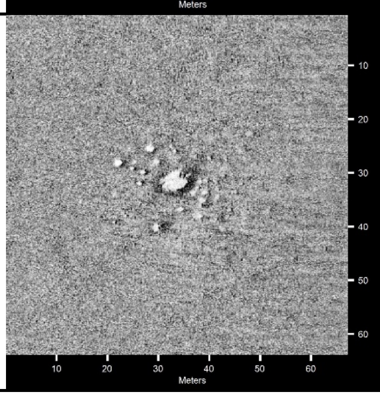
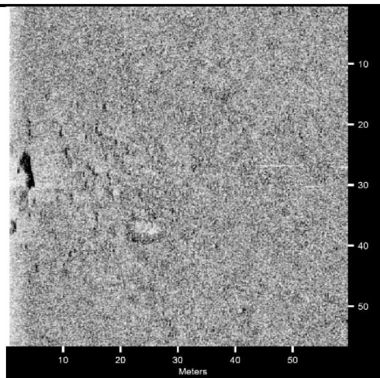
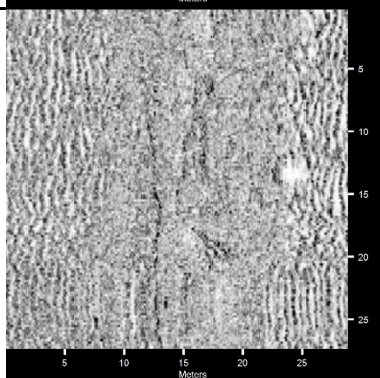
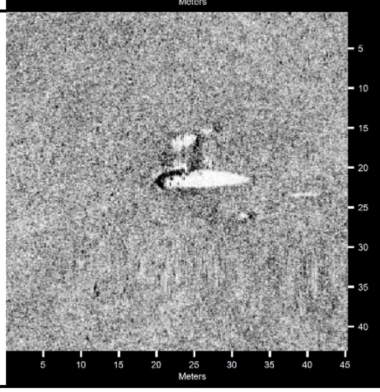
APPENDIX A

UNIDENTIFIED SONAR CONTACT AND UNIDENTIFIED MAGNETIC ANOMALY REPORTS WITH DATA REPRODUCTIONS

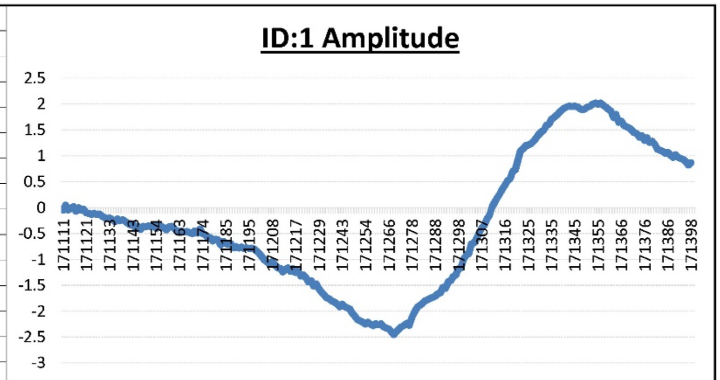
University of Southern Mississippi Site E Proposed Aquaculture Site
Unidentified Sonar Contact Report

Target Image	Target Info	User Entered Info
	**1** ● Click Position 30.0785077897 -86.9862845161 (WGS84) 30.0783015369 -86.9863225855 (NAD27LL) (X) 501321.78 (Y) 3327484.78 (Projected Coordinates) ● Map Projection: UTM84-16N ● Range to target: 59.64 Meters ● Fish Height: 13.54 Meters ● Heading: 42.110 Degrees ● Line Name: 20190521_191850_UTC_0_FL_half_A_IVER3-3072_WP26.001_Binned ● Water Depth: 37.89 Meters	**Dimensions and attributes** ● Target Width: 3 Meters ● Target Height: 2 Meters ● Target Length: 5 Meters ● Target Shadow: 8 Meters ● Mag Anomaly: 6 ● Avoidance Area: None ● Classification1: Debris ● Classification2: ● Area: Pensacola ● Block: 896 ● Description:
	**2** ● Click Position 30.0746589308 -86.9843107639 (WGS84) 30.0744525798 -86.9843489101 (NAD27LL) (X) 501512.06 (Y) 3327058.32 (Projected Coordinates) ● Map Projection: UTM84-16N ● Range to target: 35.72 Meters ● Fish Height: 10.22 Meters ● Heading: 48.470 Degrees ● Line Name: 20190528_131550_UTC_0_FL_half_B_IVER3-3072_WP26.001_Binned ● Water Depth: 45.13 Meters	**Dimensions and attributes** ● Target Width: 1 Meters ● Target Height: 0 Meters ● Target Length: 3 Meters ● Target Shadow: 1 Meters ● Mag Anomaly: None ● Avoidance Area: None ● Classification1: Linear Debris ● Classification2: ● Area: Pensacola ● Block: 896 ● Description:
	**3** ● Click Position 30.0740747419 -86.9838244069 (WGS84) 30.0738683754 -86.9838625700 (NAD27LL) (X) 501558.94 (Y) 3326993.59 (Projected Coordinates) ● Map Projection: UTM84-16N ● Range to target: 36.94 Meters ● Fish Height: 10.60 Meters ● Heading: 177.960 Degrees ● Line Name: 20190528_131550_UTC_0_FL_half_B_IVER3-3072_WP30.002_Binned ● Water Depth: 69.47 Meters	**Dimensions and attributes** ● Target Width: 5 Meters ● Target Height: 0 Meters ● Target Length: 7 Meters ● Target Shadow: 0 Meters ● Mag Anomaly: None ● Avoidance Area: None ● Classification1: Geologic ● Classification2: Large Pockmark/Depression ● Area: Pensacola ● Block: 896 ● Description:

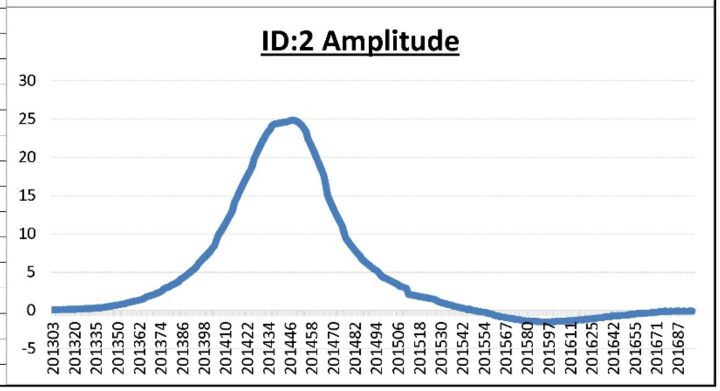
	**4** ● Click Position 30.0726805763 -86.9858823709 (WGS84) 30.0724741823 -86.9859204854 (NAD27LL) (X) 501360.62 (Y) 3326839.08 (Projected Coordinates) ● Map Projection: UTM84-16N ● Range to target: 3.84 Meters ● Fish Height: 10.60 Meters ● Heading: 176.500 Degrees ● Line Name: 20190528_131550_UTC_0_FL_half_B_IVER3-3072_WP30.002_Binned ● Water Depth: 70.67 Meters	**Dimensions and attributes** ● Target Width: 1 Meters ● Target Height: 0 Meters ● Target Length: 6 Meters ● Target Shadow: 0 Meters ● Mag Anomaly: None ● Avoidance Area: None ● Classification1: Debris ● Classification2: ● Area: Pensacola ● Block: 896 ● Description:
	**5** ● Click Position 30.0714352440 -86.9915197168 (WGS84) 30.0712288364 -86.9915576831 (NAD27LL) (X) 500817.32 (Y) 3326701.03 (Projected Coordinates) ● Map Projection: UTM84-16N ● Range to target: 42.79 Meters ● Fish Height: 12.11 Meters ● Heading: 220.240 Degrees ● Line Name: 20190528_131550_UTC_0_FL_half_B_IVER3-3072_WP14.003_Binned ● Water Depth: 40.37 Meters	**Dimensions and attributes** ● Target Width: 1 Meters ● Target Height: 0 Meters ● Target Length: 2 Meters ● Target Shadow: 2 Meters ● Mag Anomaly: None ● Avoidance Area: None ● Classification1: Debris ● Classification2: ● Area: Pensacola ● Block: 940 ● Description:
	**6** ● Click Position 30.0685067961 -86.9895883555 (WGS84) 30.0683003126 -86.9896263921 (NAD27LL) (X) 501003.49 (Y) 3326376.55 (Projected Coordinates) ● Map Projection: UTM84-16N ● Range to target: 44.27 Meters ● Fish Height: 10.31 Meters ● Heading: 180.440 Degrees ● Line Name: 20190528_131550_UTC_0_FL_half_B_IVER3-3072_WP30.004_Binned ● Water Depth: 67.05 Meters	**Dimensions and attributes** ● Target Width: 2 Meters ● Target Height: 2 Meters ● Target Length: 4 Meters ● Target Shadow: 11 Meters ● Mag Anomaly: None ● Avoidance Area: None ● Classification1: Debris ● Classification2: ● Area: Pensacola ● Block: 940 ● Description:

University of Southern Mississippi Site E Proposed Aquaculture Site
Unidentified Magnetic Anomaly Report

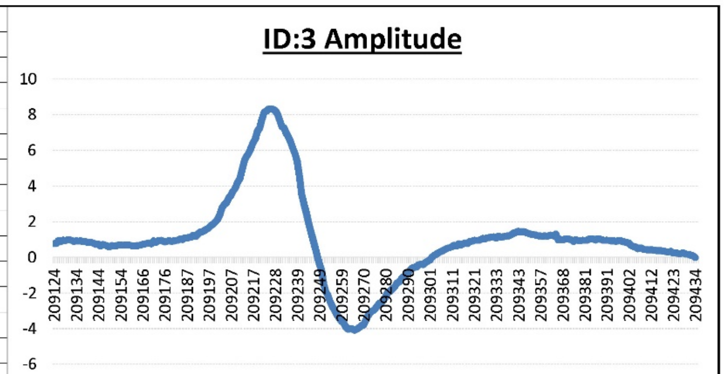
ID	1
Easting	500782.11
Northing	3326611.34
Latitude	3326611° 20.4032' N
Longitude	500782° 06.5999' E
Line	Maggy_XYZ_1
Gamma	0.10
Peak-to-Peak	4.47
Duration	28.64
Type	DIPOLE
Description	unknown mag anomaly-1



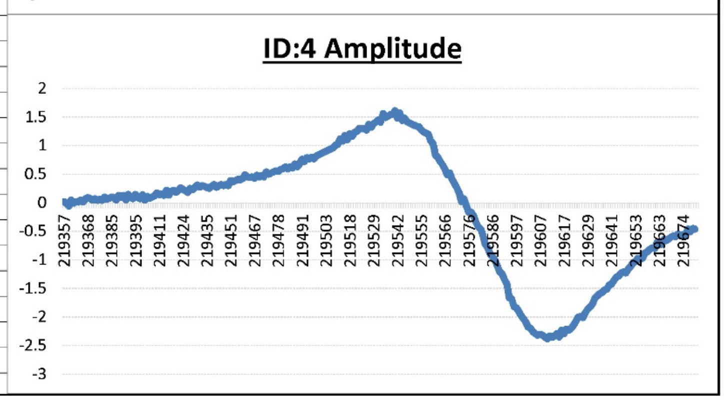
ID	2
Easting	501960.69
Northing	3327900.44
Latitude	3327900° 26.4032' N
Longitude	501960° 41.3999' E
Line	Maggy_XYZ_1
Gamma	24.63
Peak-to-Peak	26.34
Duration	52.53
Type	MONOPOLE
Description	unknown mag anomaly-2



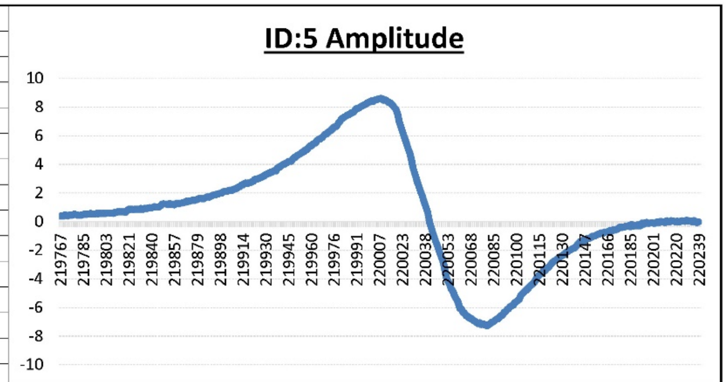
ID	3
Easting	501363.19
Northing	3327351.80
Latitude	3327351° 48.0032' N
Longitude	501363° 11.3999' E
Line	Maggy_XYZ_1
Gamma	3.53
Peak-to-Peak	12.41
Duration	58.18
Type	DIPOLE
Description	unknown mag anomaly-3



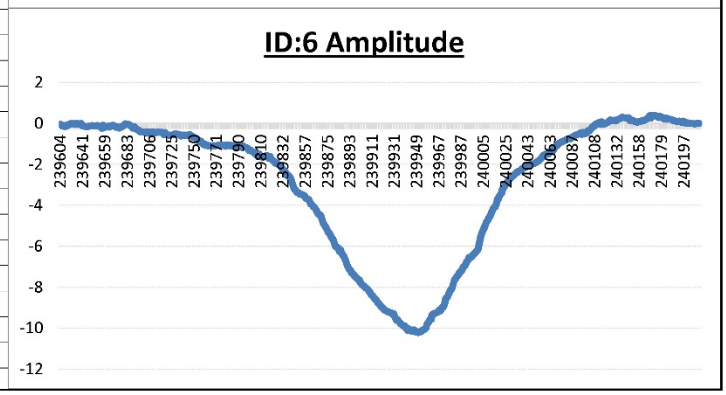
ID	4
Easting	500815.65
Northing	3326858.46
Latitude	3326858° 27.6032' N
Longitude	500815° 38.9999' E
Line	Maggy_XYZ_1
Gamma	0.17
Peak-to-Peak	3.99
Duration	39.18
Type	DIPOLE
Description	unknown mag anomaly-4



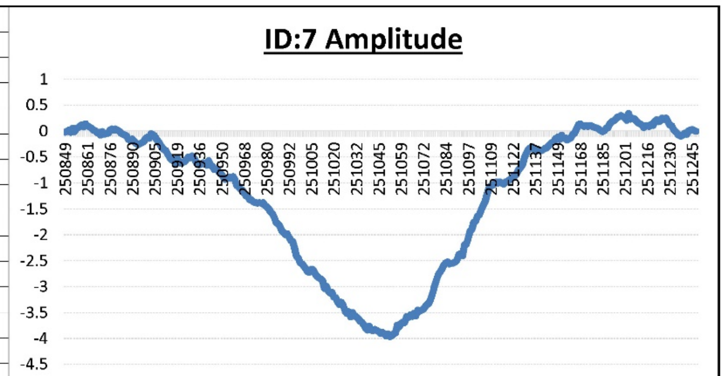
ID	5
Easting	500856.48
Northing	3326900.82
Latitude	3326900° 49.2032' N
Longitude	500856° 28.7999' E
Line	Maggy_XYZ_1
Gamma	1.22
Peak-to-Peak	15.88
Duration	60.78
Type	DIPOLE
Description	unknown mag anomaly-5



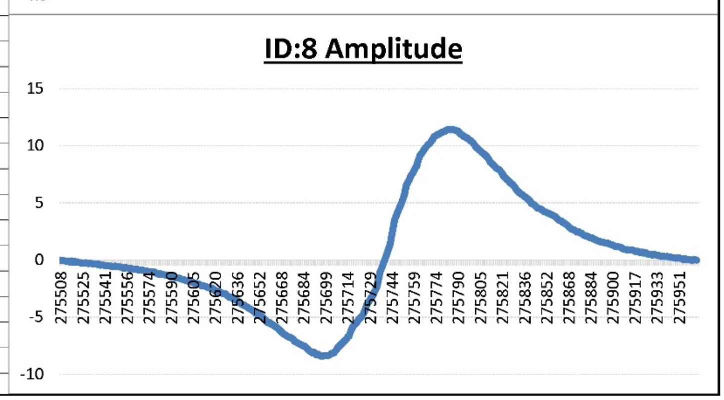
ID	6
Easting	501328.80
Northing	3327455.11
Latitude	3327455° 06.6032' N
Longitude	501328° 47.9999' E
Line	Maggy_XYZ_1
Gamma	-10.14
Peak-to-Peak	10.60
Duration	82.15
Type	MONOPOLE
Description	unknown mag anomaly-6



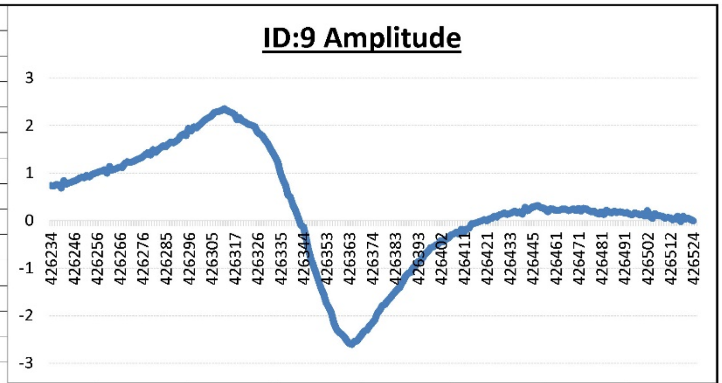
ID	7
Easting	501660.29
Northing	3327881.52
Latitude	3327881° 31.2032' N
Longitude	501660° 17.3999' E
Line	Maggy_XYZ_1
Gamma	-3.90
Peak-to-Peak	4.30
Duration	59.78
Type	MONOPOLE
Description	unknown mag anomaly-7



ID	8
Easting	501617.75
Northing	3327905.90
Latitude	3327905° 54.0032' N
Longitude	501617° 44.9999' E
Line	Maggy_XYZ_1
Gamma	2.14
Peak-to-Peak	19.88
Duration	59.33
Type	DIPOLE
Description	unknown mag anomaly-8



ID	9
Easting	500856.18
Northing	3327902.87
Latitude	3327902° 52.2032' N
Longitude	500856° 10.7999' E
Line	Maggy_XYZ_1
Gamma	-1.10
Peak-to-Peak	4.95
Duration	36.40
Type	DIPOLE
Description	unknown mag anomaly-9



APPENDIX B

BOAT SETBACK INFORMATION
EQUIPMENT SETTINGS
PROJECT PERSONNEL
SURVEY LOGS

SURVEY VESSEL *R/V LEMOYNE* SETBACK INFORMATION

The survey vessel used was the 29-foot *R/V LeMoyne*. This is a primary survey vessel for the Hydrographic science program at the university of Southern Mississippi. At the time of this survey it was equipped with Applanix POSMV Inertially aided positioning and motion system. The system includes Primary and secondary antennas and Inertial Motion unit. The location of these units are as indicated in following table. The vessel was also equipped with a C-Nav GNSS DGPS system. Which received Realtime corrections for vessel position from geostationary satellites. The multibeam system was mounted on the stbd side of the vessel using a pole. The sub-bottom profiler was deployed and towed from a davit on the starboard side of the vessel. The magnetometer was towed from a separate towpoint at the stern of the vessel. Following table gives offsets for all the systems involved in this survey.

Equipment	**X (positive forward)**	**Y (Positive stbd)**	**Z (positive down)**	**Cable out (m)**
Reference Point (approximate center of gravity of the vessel)	0	0	0	
Applanix POS MV GNSS Primary Antenna	2.439	-0.929	-2.183	NA
Applanix POS MV GNSS Secondary Antenna	-1.565	-0.929	-2.179	NA
C-Nav GNSS DGPS Antenna	-2.569	-0.895	-2.115	NA
Applanix POS MV IMU	1.431	-0.567	-0.264	
SBP Towpoint	-1.10	1.640	-1.70	30
Magnetometer Towpoint	-2.770	0.00	-1.904	177

INSTRUMENT SETTINGS

KONGSBERG EM2040C MULTIBEAM SONAR
Frequency = 300 kHz
Swath width= 65 degree on port and on stbd side. Total swath width is 130 degrees.
Record Length (Pulse length) = Auto set by data collection software for survey depth and signal attenuation. Approximate value was 1hz
Record Divisions (Ping frequency or sounding frequency)= Auto set by data collection software for survey depth.
Transducer Depth = 0.650M below water line

Edgetech 3100P SUBBOTTOM PROFILER
Frequency = 2 kHz to 15Khz Chirp
Record Length (Pulse length) = 20 msecs
Record Divisions = 5.7Hz (auto maximized)
Transducer Depth = towed at approximately 20m below waterline
Setback = 30m from tow point

EDGETECH 2205 SIDE SCAN SONAR MOUNTED ON IVER3 AUV
Range = 10 times height above seafloor (about 100to 130m) per channel
Record Divisions = 50 meters
Frequency = 590 kHz
Setback = NA

GEOMETRICS 882 CESIUM MAGNETOMETER
Sensitivity = +/- 0.1 gamma
Sampling rate = 0.1 second
Scale Divisions = 20 gammas
Setback = 177m from tow point

UNIVERSITY OF SOUTHERN MISSISSIPPI SURVEY PERSONNEL

Name	Title	Affiliation	Duties
Dr. Anand Hiroji	Professor of Hydrography	USM	Data Acquisition / Survey planning
Dr. Gero Nootz	Professor of Ocean Engineering	USM	Iver3 Operation
Dr. Vishwamithra Sunkara	Post-Doc Ocean Engineering	USM	Iver3 Operation
Mr. Marvin Story	Hydrographic Technician	USM	Vessel operator/towfish deployment
Mr. Ryan Harner	MS in Hydrographic Science Graduate Student	USM	Vessel operator/towfish deployment

P&C SCIENTIFIC, LLC PERSONNEL

Name	Title	Affiliation	Duties
Daniel Warren	Marine Archaeology Principal Investigator/President	P&C Scientific, LLC	Archaeological Assessment and Reporting

Subbottom Profiler Survey Log: 05212019 / 05222019

SBP

line/Time	SOL	Alt	below towfish Depth	EOL	Alt	Depth	Cable out
31	2001	30	20	2011	30	20	30
29	2013	35	16	2024	40	8	30
27	2025	39	9	2038	44	8	30
25	2040	45	8	2051	41	8	30
	USED HYPACK COMPUTER Clock 6 min Slow, Now Correct						
23	2059	41	9	2111	45	10	30
21	2113	47	7	2123	43	8	30
19	2124	43	9	2136	47	8	30
17	2139	48	8	2148	45	7	30
15	1444	44	7	1451	42	6	30
13	1453	45	9	1504	46	6	30
11	1505	45	10	1516	49	0	30
9	1519	47	11	1530	50	7	30
7	1531	51	9	1542	53	7	30
5	1544	55	7	1555	54	6	30
3	1556	56	8	1607	57	8	30
1	1610	61	8	1621	63	7	30
Xline 37	1626	65	6	1635	41	8	30
Xline 31	1638	38	9	1648	63	9	30
Xline 25	1651	67	6	1659	41	7	30
Xline 19	1702	40	8	1712	62	10	30
Xline 13	1715	65	5	1723	41	7	30
Xline 7	1726	41	9	1736	60	9	30
Xline 1	1738	61	6	1747	43	7	30
31	1758	42	8	1809	40	7	30

Pulse type: SB-216S, 2.0-15.0 kHz, 20 ms, FMD 25'22
SR-21.201 kHz
Actual Ping Rate 5.7 Hz
5/22/19 8-13 kts [illegible] 3-4 ft Seas

Magnetometer Survey Log: 05232019

Magnetometer. 23rd May

14 lines

line/Time	SOL	Alt	total Water Depth	EOL	Alti	Depth	Cable out
01	1400	34	69	1430	14	67	177
05	1438	10	63	1507	20	61	177
09	1511	33.6	56	1538	22	60	177
013	1540	14	55	1609	10	53	177
17	1615	11	53	1644	8	56	177
21	1651	5	54	1720	5.5	51	177
25	1724	11	49	1752	6	53	177
29	1757	9	51	1829	4	47	177
19	1834	3.5	52	1903	6	55	177
15	1908	9	57	1944	10	53	177
11	1945	10	54	2015	5	57	177
20	2020	20 13	54	2050	12	51	177
16	2054	7.3	53	2123	5	57	177
12	2128	10	56	2201	6	53	177
18							
14							
10							

Magnetometer Survey Log: 05282019

28th May

line/Time	SOL	Altn ~~Depth~~	total water Depth ~~Att~~	EOL	Alt	Dep	Cable out
10	1338	11	56	1406	12	58	177
07	1410	12	60	1442	9	58	177
03	1448	7	64	1519	7	64	177
18	1527	8	55	1556	5	51	177
23	1600	9	50	1625	6	54	177
22	1629	9	53	1658	5	53	177
14	1705	6	54	1732	8	58	177
08	1737	8	59	1810	9	57	177
06	1828	6	60	1858	6	62	177
04	1903	6	64	1937	5	63	177
02	1941	17	67	2013	10	65	177
24	2022	7	52	2050	7	49	177
27	2054	8	48	2118	7	52	177
31	2122	10	50	2,50	7	49	177
26 ~~29~~	2154	7	49	2217	8	52	177
28 ~~25~~	2221	8	51	2247	7	48	177
30	2252	6	47	2315	6	51	177

IVER3 AUV Sidescan Survey Log: 05212019 / 05222019 / 05282019

Date	Line	Waypoints	Start Time	End Time	File Name
			5/21/2019		
5/21/2019	1	5-6	Tue May 21 19:22:15 2019	Tue May 21 19:28:48 2019	20190521_191850_UTC_0_FL_half_A_IVER3-3072_WP6_Binned
5/21/2019	1	5-6	Tue May 21 19:28:48 2019	Tue May 21 19:35:20 2019	20190521_191850_UTC_0_FL_half_A_IVER3-3072_WP6.001_Binned
5/21/2019	1	5-6	Tue May 21 19:35:21 2019	Tue May 21 19:41:53 2019	20190521_191850_UTC_0_FL_half_A_IVER3-3072_WP6.002_Binned
5/21/2019	1	5-6	Tue May 21 19:41:53 2019	Tue May 21 19:44:13 2019	20190521_191850_UTC_0_FL_half_A_IVER3-3072_WP6.003_Binned
5/21/2019	2	9-10	Tue May 21 19:46:30 2019	Tue May 21 19:53:03 2019	20190521_191850_UTC_0_FL_half_A_IVER3-3072_WP10_Binned
5/21/2019	2	9-10	Tue May 21 19:53:03 2019	Tue May 21 19:59:36 2019	20190521_191850_UTC_0_FL_half_A_IVER3-3072_WP10.001_Binned
5/21/2019	2	9-10	Tue May 21 19:59:36 2019	Tue May 21 20:06:09 2019	20190521_191850_UTC_0_FL_half_A_IVER3-3072_WP10.002_Binned
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Project: Proposed Aquaculture Site for Manna Fish Farm
Legend
Magnetometer Shotpoints
SSS Shotpoints
MBES Shotpoints
SBP Shotpoints
Magnetometer Tracklines
SSS Tracklines
MBES Tracklines
SBP Tracklines
Survey Area Bounds
Prepared By: Ryan Harner (The University of Southern Mississippi)
Date: 06/26/2019
Checked By: Dr. Anand Hiroji (The University of Southern Mississippi)
Date: 06/26/2019
Coordinate System: WGS 1984 UTM Zone 16N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -87.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter
0 125 250 500 750 1,000
Meters
N
87°0'0"W
500584
86°59'0"W
502108
86°58'0"W
503632
30°5'0"N
3327660
30°4'0"N
3326136
Fin_fish_Farm_XLine_31
Fin_fish_Farm_XLine_19
Fin_fish_Farm_XLine_7
Fin_fish_Farm_XLine_37
Fin_fish_Farm_XLine_25
Fin_fish_Farm_XLine_13
Half_A_WP6
Fin_fish_Farm_27
Half_A_WP14
Fin_fish_Farm_23
Half_A_WP22
Fin_fish_Farm_19
Half_B_WP6
Half_B_WP14
Half_B_WP22
Half_B_WP30
Fin_fish_Farm_07
Fin_fish_Farm_03
Fin_fish_Farm_31
Fin_fish_Farm.001
Half_A_WP10
Fin_fish_Farm_25
Half_A_WP18
Fin_fish_Farm_21
Half_A_WP26
Half_B_WP10
Fin_fish_Farm_13
Half_B_WP18
Fin_fish_Farm_09
Half_B_WP26
Fin_fish_Farm_05
Half_B_WP34
Fin_fish_Farm_01

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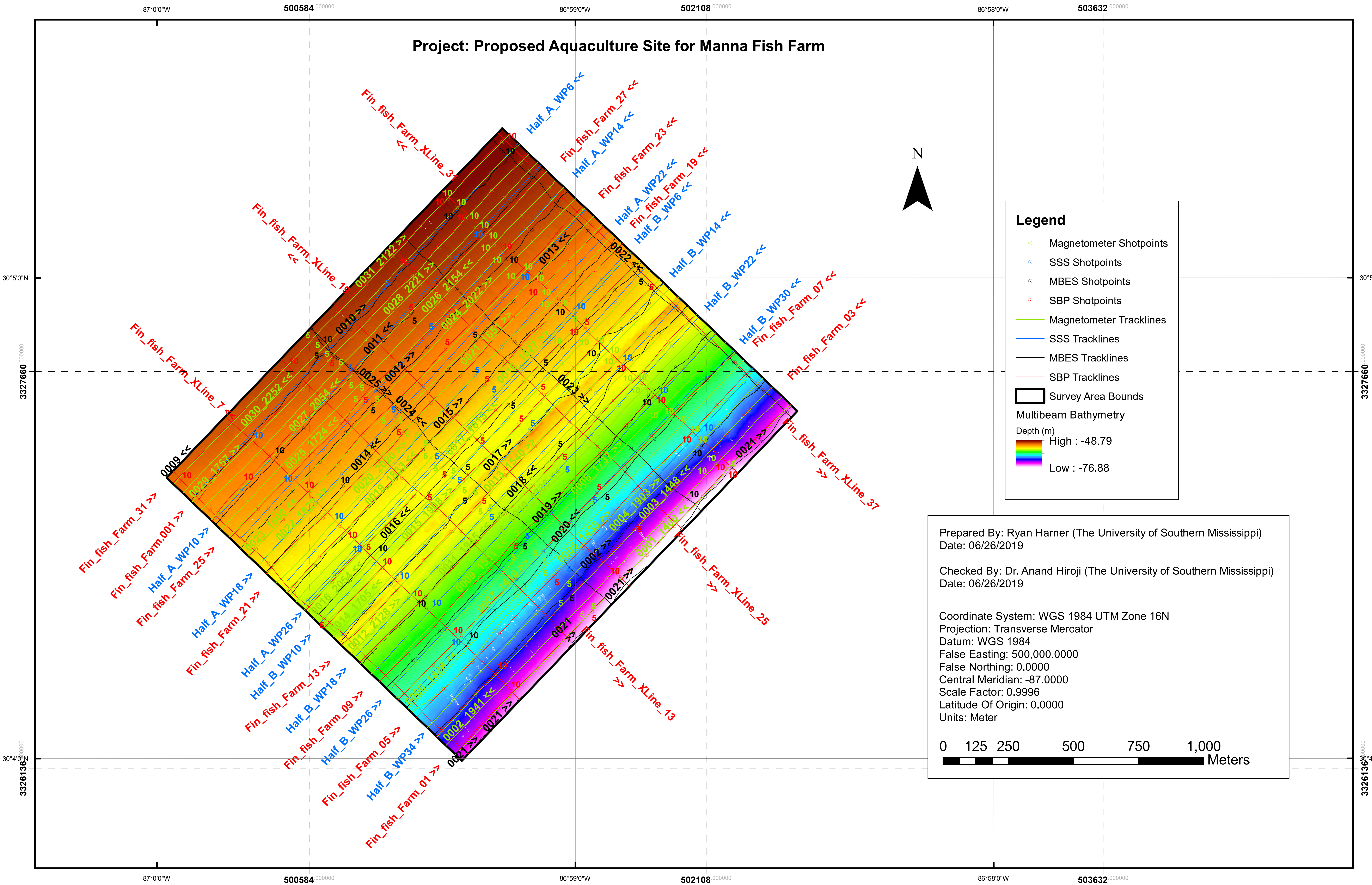
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500584
86°59'0"W
502108
86°58'0"W
503632
30°5'0"N
30°4'0"N
3327660
3326136
N
Legend
Magnetometer Shotpoints
SSS Shotpoints
MBES Shotpoints
SBP Shotpoints
Magnetometer Tracklines
SSS Tracklines
MBES Tracklines
SBP Tracklines
Survey Area Bounds
Multibeam Bathymetry
Depth (m)
High : -48.79
Low : -76.88
Fin_fish_Farm_XLine_3 <<
Fin_fish_Farm_XLine_19 <<
Fin_fish_Farm_XLine_7 <<
Half_A_WP6 <<
Fin_fish_Farm_27 <<
Half_A_WP14 <<
Fin_fish_Farm_23 <<
Half_A_WP22 <<
Fin_fish_Farm_19 <<
Half_B_WP6 <<
Half_B_WP14 <<
Half_B_WP22 <<
Half_B_WP30 <<
Fin_fish_Farm_07 <<
Fin_fish_Farm_03 <<
Fin_fish_Farm_XLine_37 >>
Fin_fish_Farm_XLine_25 >>
Fin_fish_Farm_XLine_13 >>
Fin_fish_Farm_31 >>
Fin_fish_Farm.001 >>
Half_A_WP10 >>
Fin_fish_Farm_25 >>
Half_A_WP18 >>
Fin_fish_Farm_21 >>
Half_A_WP26 >>
Half_B_WP10 >>
Fin_fish_Farm_13 >>
Half_B_WP18 >>
Fin_fish_Farm_09 >>
Half_B_WP26 >>
Fin_fish_Farm_05 >>
Half_B_WP34 >>
Fin_fish_Farm_01 >>
Prepared By: Ryan Harner (The University of Southern Mississippi)
Date: 06/26/2019
Checked By: Dr. Anand Hiroji (The University of Southern Mississippi)
Date: 06/26/2019
Coordinate System: WGS 1984 UTM Zone 16N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -87.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter
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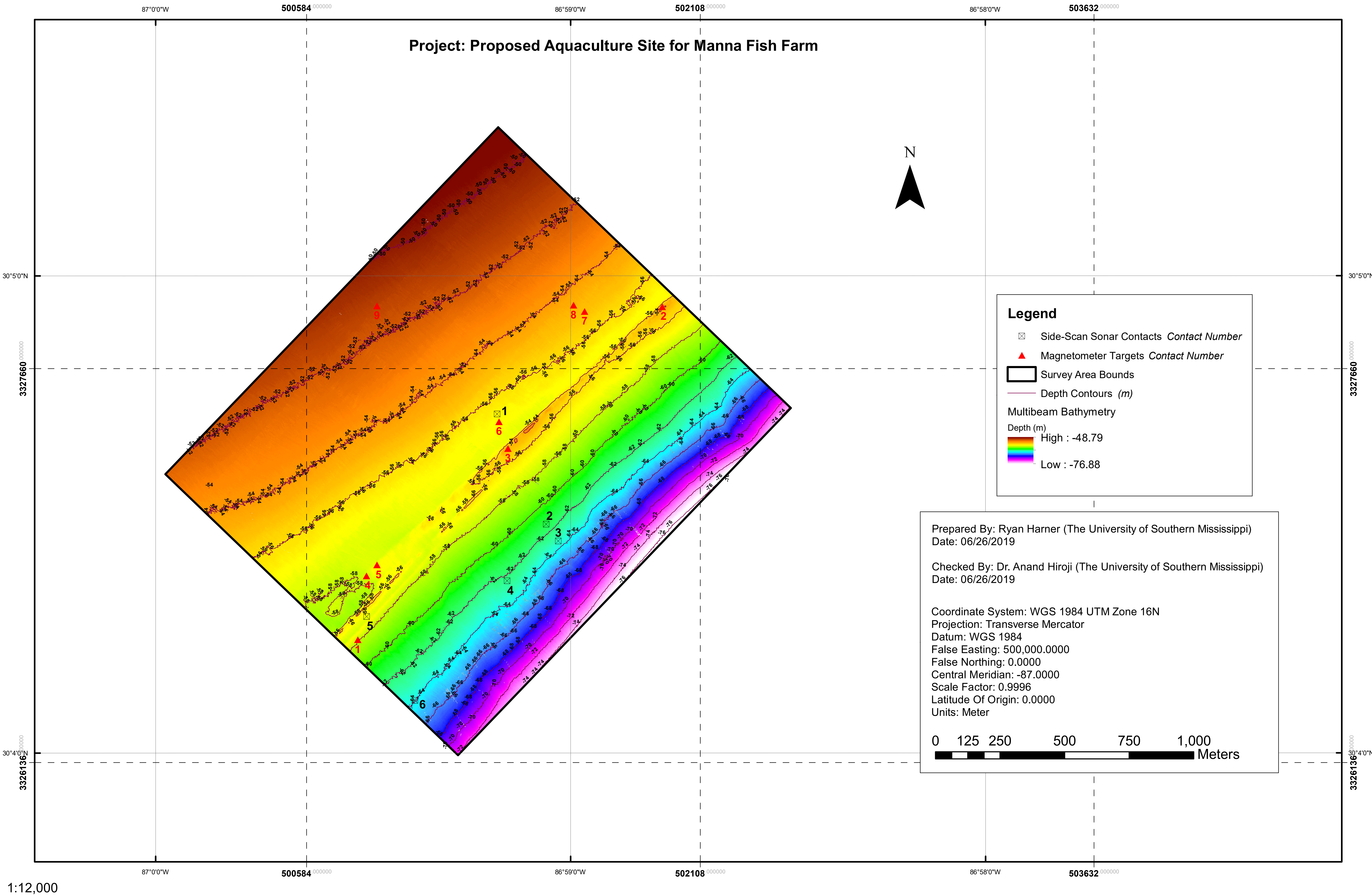
Meters

1:12,000



Project: Proposed Aquaculture Site for Manna Fish Farm
87°0'0"W
500584
86°59'0"W
502108
86°58'0"W
503632
30°5'0"N
3327660
30°4'0"N
3326136
N
1
2
3
4
5
6
7
8
9
Legend
Side-Scan Sonar Contacts *Contact Number*
Magnetometer Targets *Contact Number*
Survey Area Bounds
Depth Contours *(m)*
Multibeam Bathymetry
Depth (m)
High : -48.79
Low : -76.88
Prepared By: Ryan Harner (The University of Southern Mississippi)
Date: 06/26/2019
Checked By: Dr. Anand Hiroji (The University of Southern Mississippi)
Date: 06/26/2019
Coordinate System: WGS 1984 UTM Zone 16N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -87.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter
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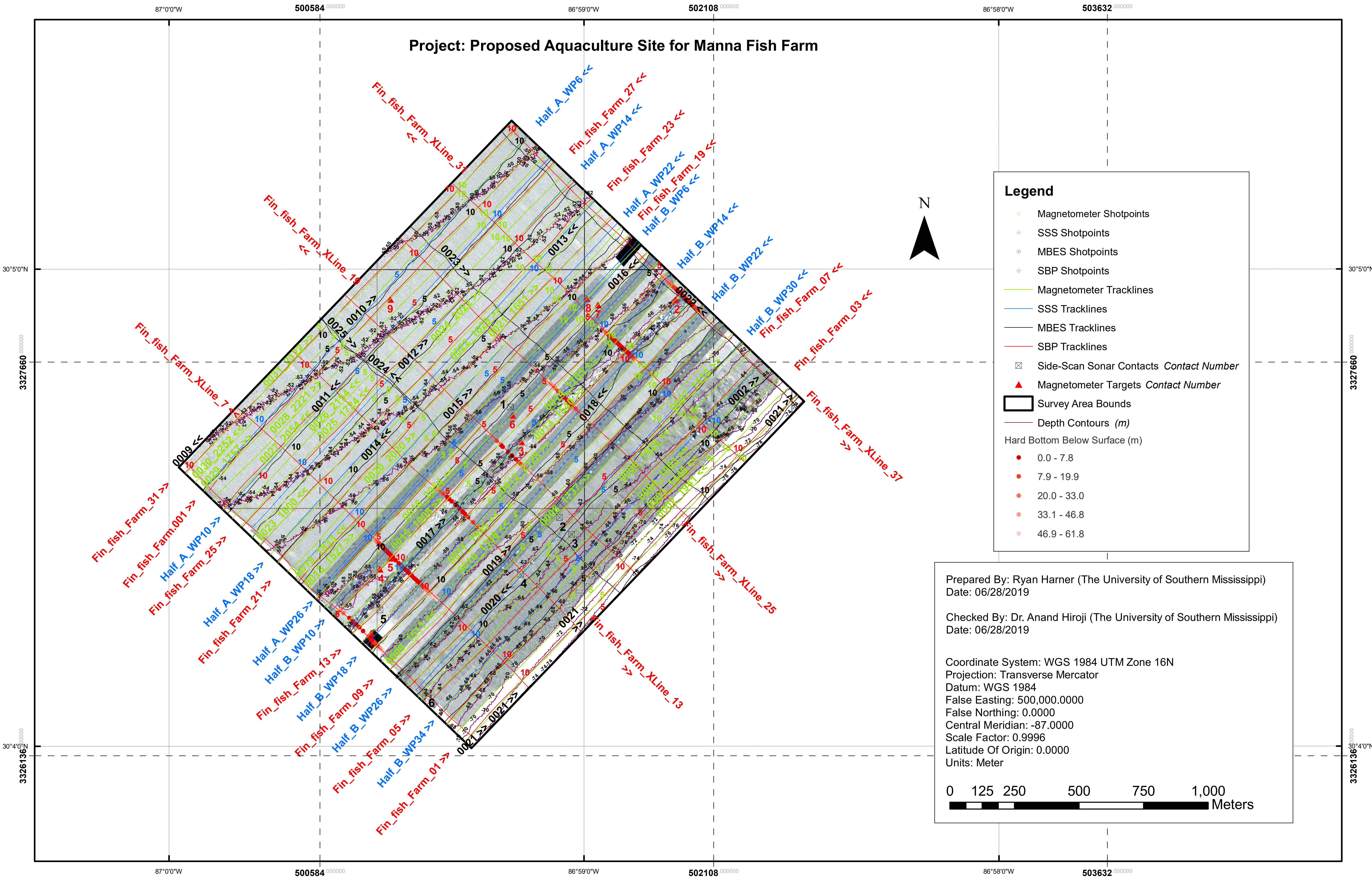
Meters
1:12,000


Project: Proposed Aquaculture Site for Manna Fish Farm
87°0'0"W
500584
86°59'0"W
502108
86°58'0"W
503632
30°5'0"N
3327660
30°4'0"N
3326136
N
Legend
Magnetometer Shotpoints
SSS Shotpoints
MBES Shotpoints
SBP Shotpoints
Magnetometer Tracklines
SSS Tracklines
MBES Tracklines
SBP Tracklines
Side-Scan Sonar Contacts Contact Number
Magnetometer Targets Contact Number
Survey Area Bounds
Depth Contours (m)
Hard Bottom Below Surface (m)
0.0 - 7.8
7.9 - 19.9
20.0 - 33.0
33.1 - 46.8
46.9 - 61.8
Prepared By: Ryan Harner (The University of Southern Mississippi)
Date: 06/28/2019
Checked By: Dr. Anand Hiroji (The University of Southern Mississippi)
Date: 06/28/2019
Coordinate System: WGS 1984 UTM Zone 16N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -87.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter
0 125 250 500 750 1,000
Meters
Fin_fish_Farm_XLine_31
Fin_fish_Farm_XLine_19
Fin_fish_Farm_XLine_7
Fin_fish_Farm_XLine_37
Fin_fish_Farm_XLine_25
Fin_fish_Farm_XLine_13
Half_A_WP6 <<
Fin_fish_Farm_27 <<
Half_A_WP14 <<
Fin_fish_Farm_23 <<
Half_A_WP22 <<
Fin_fish_Farm_19 <<
Half_B_WP6 <<
Half_B_WP14 <<
Half_B_WP22 <<
Half_B_WP30 <<
Fin_fish_Farm_07 <<
Fin_fish_Farm_03 <<
Fin_fish_Farm_31 >>
Fin_fish_Farm.001 >>
Half_A_WP10 >>
Fin_fish_Farm_25 >>
Half_A_WP18 >>
Fin_fish_Farm_21 >>
Half_A_WP26 >>
Half_B_WP10 >>
Fin_fish_Farm_13 >>
Half_B_WP18 >>
Fin_fish_Farm_09 >>
Half_B_WP26 >>
Fin_fish_Farm_05 >>
Half_B_WP34 >>
Fin_fish_Farm_01 >>

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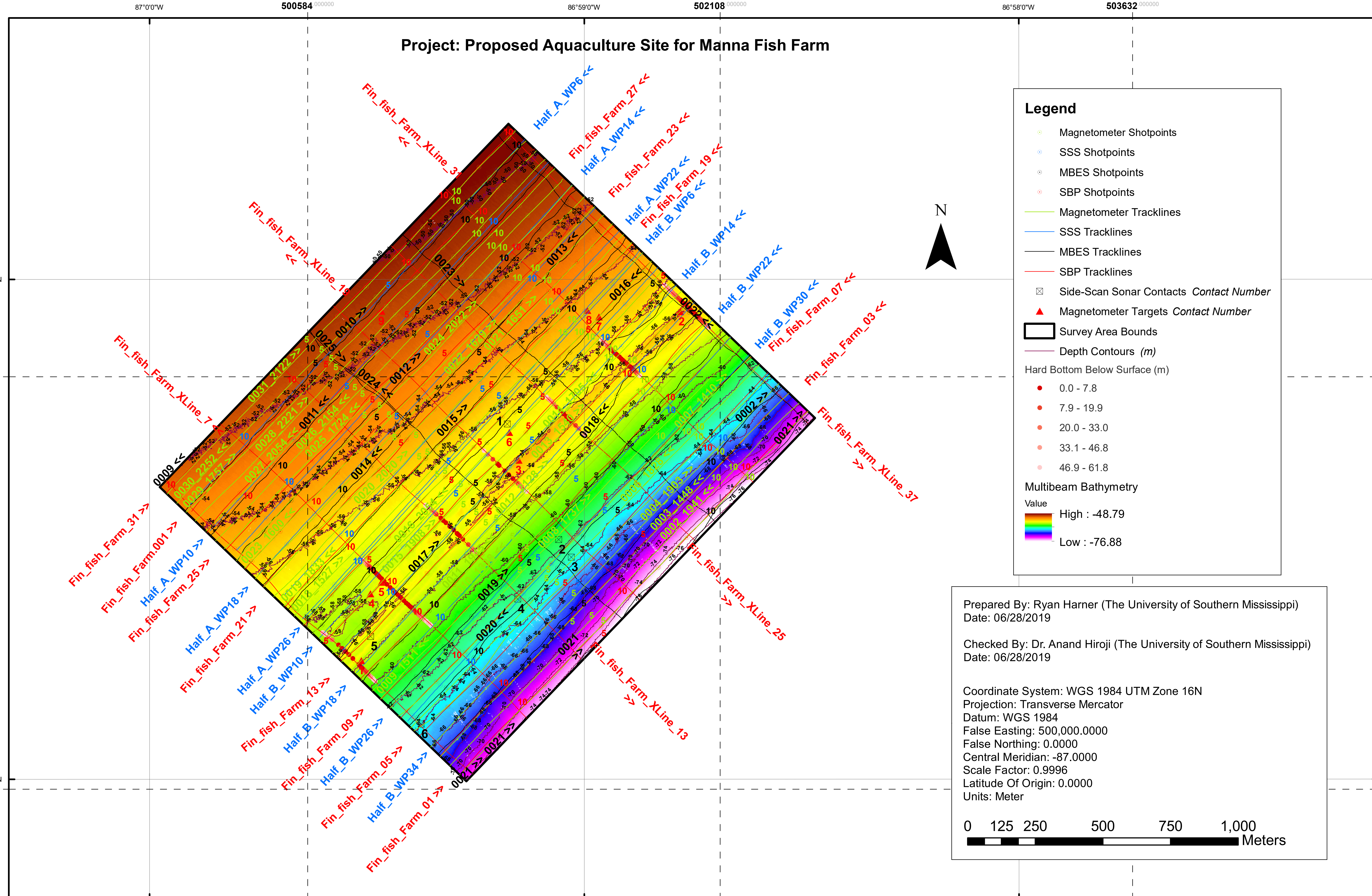

Project: Proposed Aquaculture Site for Manna Fish Farm
87°0'0"W
500584
86°59'0"W
502108
86°58'0"W
503632
30°5'0"N
30°4'0"N
3327660
3326136
N
Legend
Magnetometer Shotpoints
SSS Shotpoints
MBES Shotpoints
SBP Shotpoints
Magnetometer Tracklines
SSS Tracklines
MBES Tracklines
SBP Tracklines
Side-Scan Sonar Contacts *Contact Number*
Magnetometer Targets *Contact Number*
Survey Area Bounds
Depth Contours *(m)*
Hard Bottom Below Surface (m)
0.0 - 7.8
7.9 - 19.9
20.0 - 33.0
33.1 - 46.8
46.9 - 61.8
Multibeam Bathymetry
Value
High : -48.79
Low : -76.88
Prepared By: Ryan Harner (The University of Southern Mississippi)
Date: 06/28/2019
Checked By: Dr. Anand Hiroji (The University of Southern Mississippi)
Date: 06/28/2019
Coordinate System: WGS 1984 UTM Zone 16N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -87.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter
0 125 250 500 750 1,000
Meters
Fin_fish_Farm_XLine_31 <<
Fin_fish_Farm_XLine_19 <<
Fin_fish_Farm_XLine_7 <<
Fin_fish_Farm_XLine_37 >>
Fin_fish_Farm_XLine_25 >>
Fin_fish_Farm_XLine_13 >>
Half_A_WP6 <<
Fin_fish_Farm_27 <<
Half_A_WP14 <<
Fin_fish_Farm_23 <<
Half_A_WP22 <<
Fin_fish_Farm_19 <<
Half_B_WP6 <<
Half_B_WP14 <<
Half_B_WP22 <<
Half_B_WP30 <<
Fin_fish_Farm_07 <<
Fin_fish_Farm_03 <<
Fin_fish_Farm_31 >>
Fin_fish_Farm.001 >>
Half_A_WP10 >>
Fin_fish_Farm_25 >>
Half_A_WP18 >>
Fin_fish_Farm_21 >>
Half_A_WP26 >>
Half_B_WP10 >>
Fin_fish_Farm_13 >>
Half_B_WP18 >>
Fin_fish_Farm_09 >>
Half_B_WP26 >>
Fin_fish_Farm_05 >>
Half_B_WP34 >>
Fin_fish_Farm_01 >>

1:12,000

Appendix E:

Acoustic Doppler Current Profiler Processing Report (2019)

Current Velocity Profile Time Series at 30.08087°N and 086.98993°W

Anand Hiroji and Stephan Howden
School of Ocean Science and Engineering
The University of Southern Mississippi
1020 Balch Blvd
Stennis Space Center, MS 39529

Purpose of ADCP Deployment

This deployment was part of an Environmental Baseline Survey for an offshore aquaculture site in the northern Gulf of Mexico.

NOAA Requirements for ADCP Report

Hydrological Measurements: Reporting of the hydrological measurements (waves and currents) should contain a thorough description of the methods employed including the instrumentation used, location and depth of deployment, deployment periods and field procedures involved in the deployment, maintenance and retrieval of equipment. Descriptions should also include the number of cells (bins) measured, and data averaging protocols for the instruments used and how the data were processed and analyzed. Any problems or issues should also be discussed in the methods section.
The results should provide a description of maximum, minimum and average currents and tidal excursions and include a current rose plot of depth averaged currents and a rose plot for near surface, mid-water and near bottom currents. A plot of the tidal ellipse (magnitude and inclination of the major axis and magnitude of minor axis) should also be included.

The processed wave and current data used in the analysis should be submitted to NOAA and the EPA on CD_ROM or DVD.

Overview

The 300 kHz Teledyne/RDI Workhorse Sentinel ADCP was deployed at the approximate location of Lat 30.08087N and 86.98993W (Figure 1) for an intended duration of 90 days. The ADCP was mounted on a bottom package and put on the bottom of the ocean to avoid any surface signature. The bottom package was equipped with an acoustic release which inflates rubber bladders for the recovery. The 1st recovery attempt was a failure as the acoustic package did not trigger the inflation process. A survey was performed to confirm the existence and location of the ADCP. An accurate location and positive confirmation was obtained at the end of the survey. A second recovery was successful and the ADCP bottom package was recovered using a small ROV.
Upon retrieving the data from the ADCP it was clear that the ADCP stopped working for some unknown reason after 41 days of deployment.

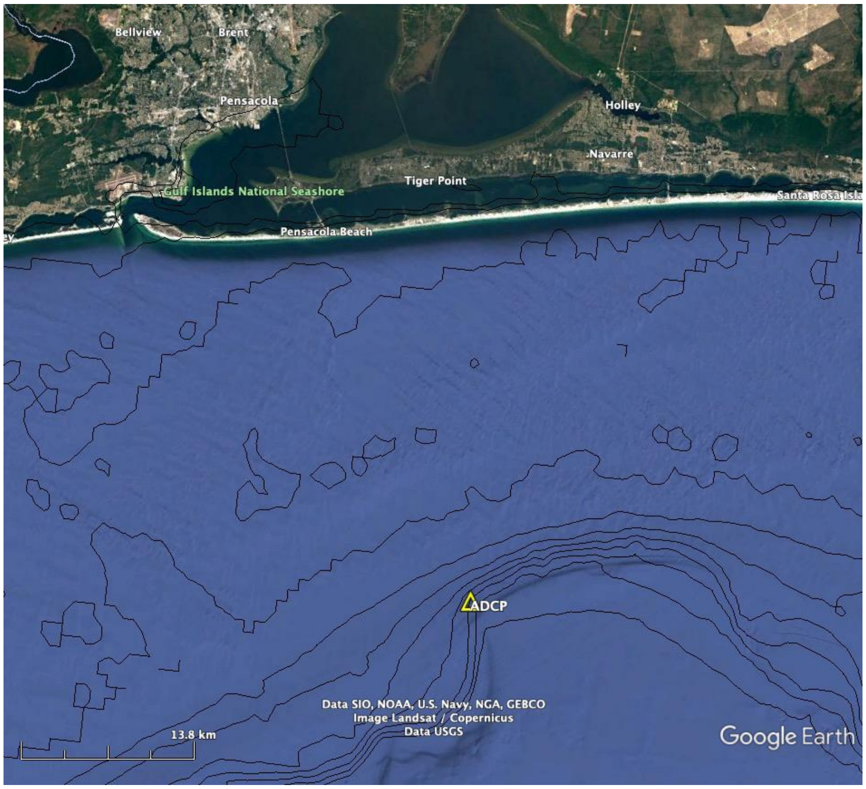


Figure 1. Location of ADCP mooring in approximately 54 m of water

Following is a summary of the data collected.
The upward looking ADCP transducer faces sit approximately 0.488m above the seafloor. Table 1 gives the coordinates of the mooring, the instrument used, the trawl-resistant bottom mooring used, the height of the ADCP transducer from the seafloor and the approximate depth of deployment. Table 2 gives the ADCP set-up details, and Table 3 gives the height from the seafloor of the 59 bins. Note that some are higher than the water depth.

Table 1. Instrument, mooring and mooring location information.

Location of Mooring (Latitude, Longitude)	(30.08087N, 086.98993W)
Instrument	300 kHz Teledyne/RDI Workhorse Sentinel
Bottom Mooring	Mooring Systems, Inc GP-TRBM
Height of Transducers above Seafloor	0.488 m
Depth of Deployment	Approximately 54 m
Deployment Date	
Recovery Date	

Table 2. Teledyne/RDI Workhorse Sentinel set-up.

Workhorse Parameters	Value
BB/WH Ensemble Length	1334 Bytes
System Frequency	307.2 kHz
Blanking Distance	1.74 m
Bin Size	1.00 m

No. Bins	59
Pings/Ens	45
Time/Ping	00:06:00
Height First Bin from ADCP transducers	2.24 m

Deployment Details

The deployment of the ADCP bottom package was carried out using the University of Southern Mississippi's R/V Jim Frank on 08/22/2019. The bottom package was attached to the ship's winch via an acoustic release. The package was lowered to the bottom and then disconnected from the winch cable by opening acoustic release by sending acoustic signal from the surface. This deployment method ensured that the ADCP package was placed at the desired location and without damaging any parts. The ADCP bottom package was a trawel-resistant package with a floatation device for recovery.

Recovery Details

The first attempt of the recovery was conducted on 11/19/2019 from R/V Jim Frank. Upon arriving at the deployed location, an acoustic signal was sent to the bottom package to release compressed gas from its storage cylinder to the flotation tubes. It was expected that the floatation tubes, once inflated, will bring the bottom package to the surface. But for reasons unknown, the bottom package did not surface upon multiple attempts. After multiple trials, a small AUV equipped with sidescan sonar was deployed to survey the area where the ADCP. After retrieving the AUV and processing the side scan sonar data, it was confirmed that the ADCP bottom package was present at its original location. The team returned as it did not have means of recovering the bottom package at that depth.

The second recovery attempt was made on 03/13/2020 using a small tethered ROV initially designed for providing a live video to the ship. The AUV was modified and equipped with a custom-made hook that can be hooked to objects on the seafloor. Again, the R/V Jim Franks was used to get to the location of the ADCP. Once arrived, the ROV and the hook were rigged to the ship's winch cable. The ROV then dove to the bottom carrying the hook attached to the ship's winch cable. In about 15 minutes, the ADCP bottom package was located, and a pilot onboard the ship looking at the live feed successfully hooked the ADCP bottom package. Once hooked, the ship's winch was used to raise the bottom package. Once on the deck, the ADCP was recovered, and data was downloaded.

The recovered file from the ADCP is named _RDI_001.000 and is in the RDI binary format. Data from this file was extracted using the Teledyne/RDI software package WinADCP. The date and time of the first ensemble is 2019/08/22 11:13:04.06 (UTC). The date and time of the last ensemble (#11974) is 2019/10/03 00:58:04.06 (UTC). The average ensemble interval is 00:05:00.00.

Table 3. ADCP bin number and height of middle of each bin from the seafloor.

Bins	Height Above Seafloor (m)
1	2.73
2	3.73
3	4.73
4	5.73
5	6.73
6	7.73
7	8.73
8	9.73
9	10.73
10	11.73
11	12.73
12	13.73
13	14.73
14	15.73
15	16.73
16	17.73
17	18.73
18	19.73
19	20.73
20	21.73
21	22.73
22	23.73
23	24.73
24	25.73
25	26.73
26	27.73
27	28.73
28	29.73
29	30.73
30	31.73
31	32.73
32	33.73
33	34.73
34	35.73
35	36.73
36	37.73
37	38.73
38	39.73
39	40.73
40	41.73
41	42.73
42	43.73
43	44.73
44	45.73
45	46.73
46	47.73
47	48.73
48	49.73
49	50.73
50	51.73
51	52.73
52	53.73
53	54.73
54	55.73
55	56.73
56	57.73
57	58.73
58	59.73
59	60.73

Data Processing

The steps of data processing included performing quality control (QC) procedures to clean up bad data, computing statistics of the QC'd data, performing harmonic analysis, and creating tables and figures of the results.

QC Procedures

The following QC procedures were performed on the data.

QC Step1: Compute maximum range and maximum bin to use

The first step was to compute the maximum range of the data to use based on the bins that would not be contaminated by surface returns in the side lobes of the transducers. From [1] the maximum range from the transducers is

$$R\_\{max\} = H\backslash cos\{\backslash theta\}$$

where H is the height of the water above the transducer and \theta is the angle of the transducer heads with respect to the vertical. For the 300kHz Workhorse Sentinel, \theta=20^o.

The nominal water depth is 54.0 m with respect to MLLW at the mooring location. The height of the transducer above the seafloor is approximately 0.488 m. The height of the water above the transducer then approximately 53.5 m. Rmax is then

Rmax=53.5 m * cos(20) = 50 m.

Bin 48 is 49.73 m above the seafloor (Table x), so only the first 48 bins were subsequently used.

QC Step 2: Maximum Tilt Check

A check to only keep ADCP data when the instrument tilt was 15^{o} or less was performed [1]. This test resulted in throwing out 6 of the 11974 ensembles.

QC Step 3: Correlation Magnitude Check

Following [1], a test was performed to only keep data when at least 3 beams have correlation magnitude values greater than or equal to 65.

QC Step 4: Percent Good Check

Following [1], a test was performed to only keep data when the sum of the Percent Good in beam 1 (PG1) and the Percent Good in beam 4 (PG4) was greater than 75:

PG1+PG4>75

QC Step 5: Current Speed Check

Following [1], a test was performed to only keep data when the maximum spped was less than or equal to 0.80 m/s.

Tidal Analysis

Harmonic Analysis of the data was performed using utide [3].

Results

QC

QC steps 2-5 resulted in reducing the data in bins 1-48 by about 10%. Figures 2-4 show Hovmoller plots of the results. Figure 2 shows the eastward component of velocity, Figure 3 the northward component and Figure 4 the speed.

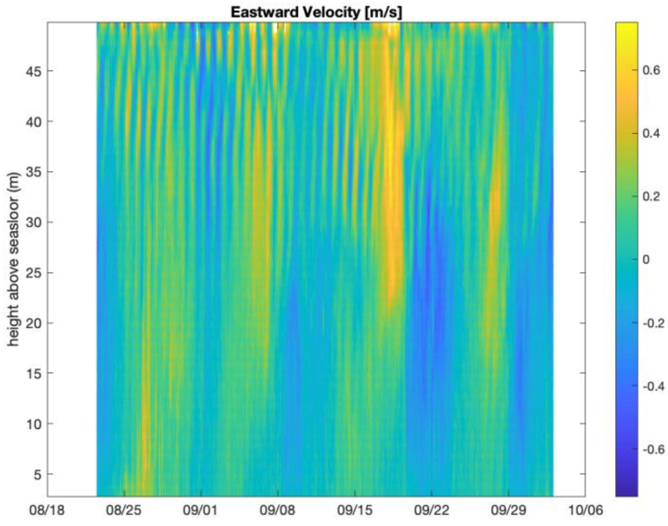


Figure 2. Hovmoller plot of eastward component of QC'd velocity. Units are m/s.

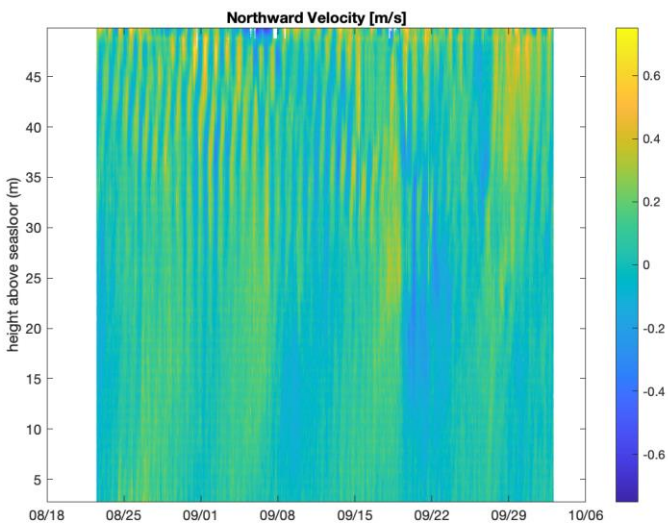


Figure 3 Hovmoller plot of northward component of QC'd velocity. Units are m/s.

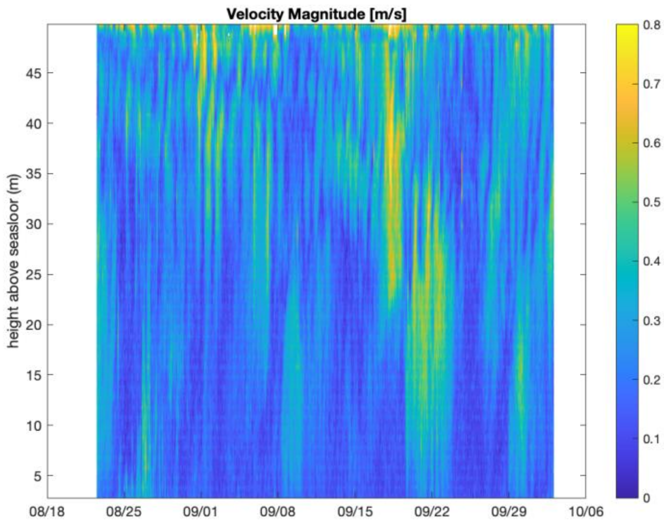


Figure 4. Hovmoller plot of speed from QC'd velocity. Units are m/s.

Depth-Averaged (Barotropic) Current

For each ensemble, the depth averaged eastward (u_{BT}) and northward (v_{BT}) components of the current were computed by averaging the QC'd data over the first 48 bins. The time series of barotropic speed (V_{BT}) was computed as the time series of

$$V_{BT} = \sqrt{u_{BT}^2 + v_{BT}^2}$$

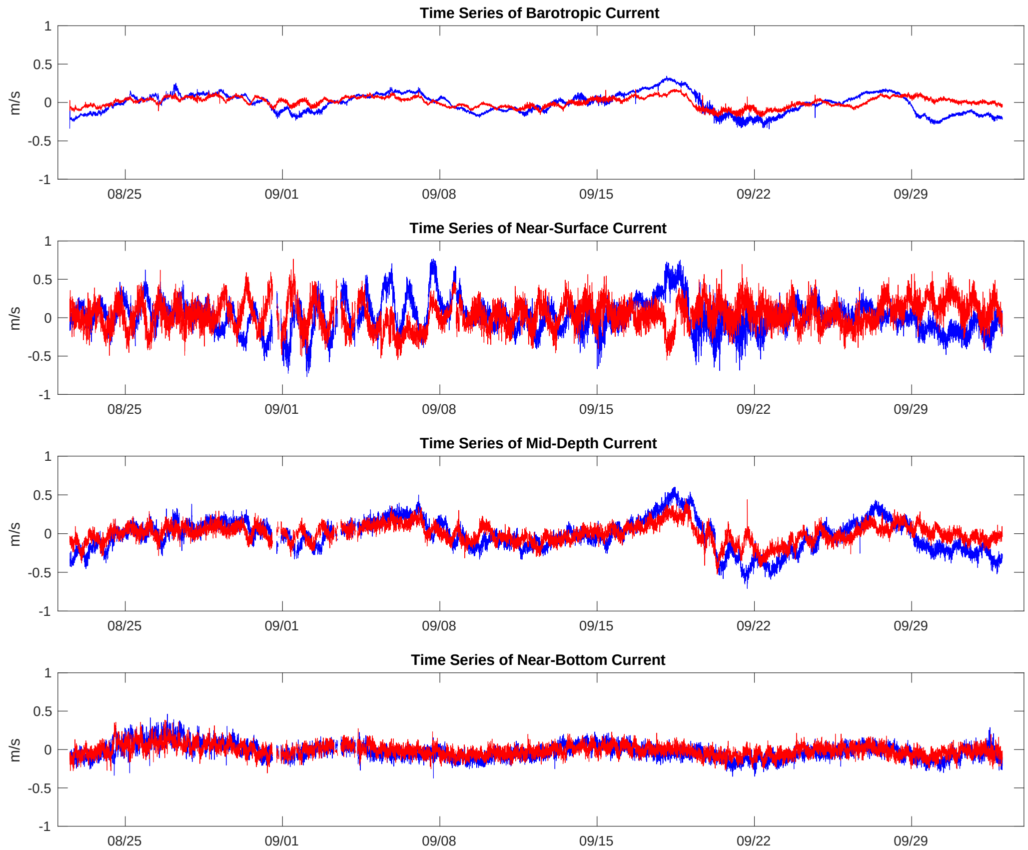


Figure 5. Time series of currents (Red: eastward component; Blue: northward component). From top panel to bottom: barotropic (depth averaged) velocity; Near-surface current (bin 47); Mid-depth currents (bin24); and Near-bottom currents (bin 1).

Statistics of the Currents

Table 4 shows the mean, maximum and minimum of the currents. The statistics of the barotropic current, a near surface current (bin 47), mid-depth current (bin 24), and near-bottom current (bin 1) are shown.

Table 4

Parameter	Mean (m/s)	Maximum (m/s)	Minimum (m/s)
u_{BT}	-0.014	0.520	-0.347
v_{BT}	0.004	0.177	-0.196
V_{BT}	0.015	0.520	0.001
$u_{nearsurf}$ (bin 47)	0.016	0.765	-0.769
$v_{nearsurf}$ (bin 47)	0.038	0.760	-0.600
$V_{nearsurf}$ (bin 47)	0.042	0.799	0.003

$u_{middepth}$ (bin 24)	-0.022	0.610	-0.673
$v_{middepth}$ (bin 24)	0.002	0.452	-0.525
$V_{nmiddepth}$ (bin 24)	0.022	0.672	0.002
$u_{nearbot}$ (bin 1)	-0.025	0.462	-0.377
$v_{nearbot}$ (bin 1)	-0.011	0.384	-0.307
$V_{nearbot}$ (bin 1)	0.027	0.485	0.002

Figure 6 shows a current rose for the barotopic currents. The plot used Matlab © code in [2]. The barotropic currents are predominately aligned on a axis in the southwest to northeast direction.

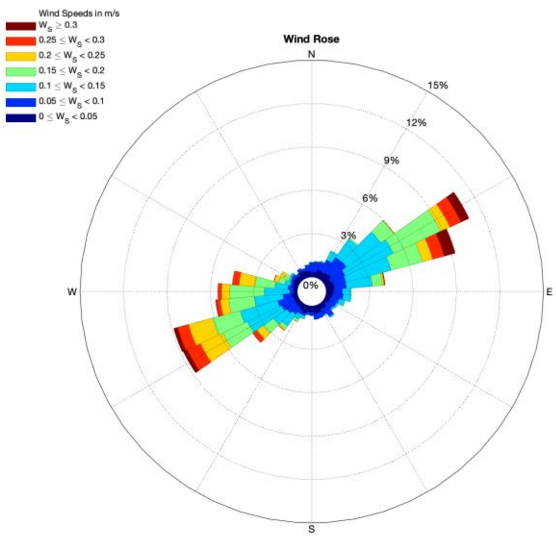


Figure 6. Current rose for depth averaged currents. The convention used for direction is direction currents are flowing towards.

Figure 7. shows the current rose for the near surface currents (bin 47). These are more isotropically distributed than the barotropic currents, with a tendency for a northwest to southeast orientation.

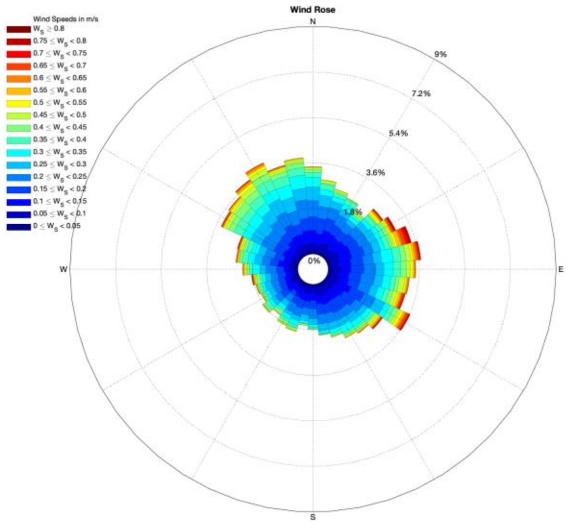


Figure 7. Current rose near surface (bin 47). The convention used for direction is direction currents are flowing towards. For comparison Figures 7-9 have the same scales.

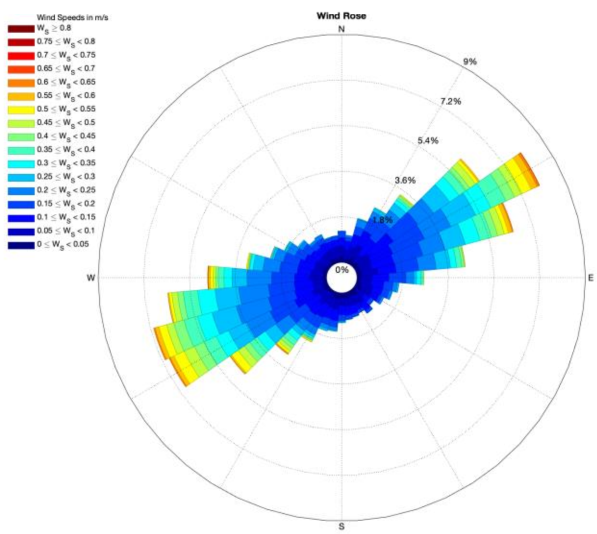


Figure 8 Current rose mid-depth (bin 24). For comparison Figures 7-9 have the same scales.

Figure 8 shows the current rose for the mid-depth currents (bin 44). These are distributed similarly to the barotropic currents.

Figure 9 shows the current rose for the near-bottom currents (bin 1). These are weaker than the near-surface and mid-depth currents, and are predominately to the southwest.

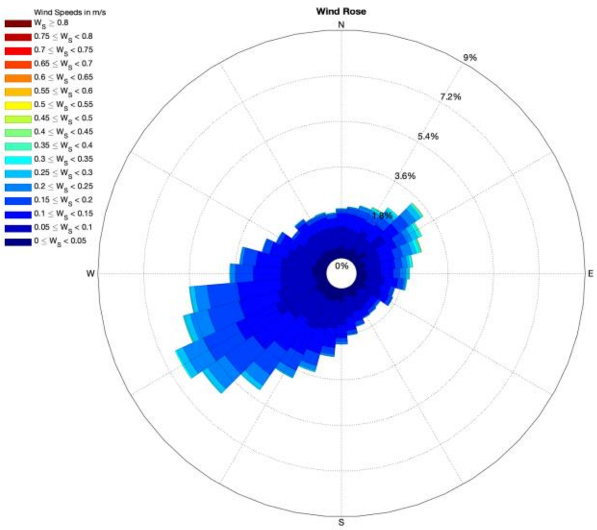


Figure 9. Current rose near bottom (bin1) . For comparison Figures 7-9 have the same scales.

Tidal Analysis

This region of the Gulf of Mexico has predominately diurnal tidal heights. The Inertial Period at the latitude of the ADCP (30.08087^{o}N) is very close to one day. The ADCP time series is approximately 41 days, so it is difficult to separate tidal energy in the diurnal band from inertial and near-inertial waves. A harmonic analysis was performed on the barotopic, near-surface, mid-depth and near-bottom currents using the Matlab © version of Utide [3]. A harmonically generated time series of at each depth was then generated over the observed time. Below are the results at each depth from this analysis.

Barotropic Current

Table 5. Utide results for the barotropic currents. The tidal constituent names with an asterisk have a signal to noise (column SNR) that is below the minimum threshold of 2. Columns are the name of the constituent, the semi-major axis (m/s) , the confidence interval of the semi-major axis (m/s), the semi-minor axis (m/s), the confidence interval for the semi-minor axis(m/s), the orientation angle (radians) of the semimajor axis, the uncertainty in the orientation angle (radians), the Greenwich phase lag (radians), the uncertainty in the Greenwich phase lag (radians), the Percent of Energy explained by the constituent, and the Signal to Noise Ratio (see [3]).

Name	Lsmaj	Lsmaj_ci	Lsmin	Lsmin_ci	theta	theta_ci	g	g_ci	PE	SNR
MSF'	0.047	0.054	0.012	0.033	44.31	23.16	17.57	104.15	53.19	2.28
MM'*	0.029	0.052	0.013	0.033	150.72	84.16	51.24	364.67	23.13	1.03
'K1'	0.021	0.004	-0.015	0.003	164.64	18.31	149.48	21.45	14.60	110.66
'OO1'	0.009	0.002	-0.004	0.003	108.69	39.11	119.87	25.47	2.07	22.28
'O1'	0.008	0.002	-0.001	0.004	109.54	31.09	178.83	21.44	1.37	10.08
'J1'	0.006	0.003	0.000	0.003	151.08	25.73	332.57	30.66	0.87	7.32
'ALP1'	0.006	0.004	-0.002	0.003	26.45	27.61	16.65	48.15	0.87	7.03
'ETA2'	0.005	0.001	0.000	0.001	168.81	10.27	287.62	16.13	0.50	45.30
'S2'	0.004	0.001	-0.001	0.001	113.82	18.69	152.28	16.37	0.48	38.69
'2Q1'	0.004	0.003	-0.002	0.002	4.00	155.15	334.31	170.96	0.42	4.13
'Q1'	0.004	0.003	0.000	0.002	14.85	41.49	136.86	81.47	0.38	3.83
'NO1'	0.004	0.002	0.002	0.003	108.16	81.30	200.61	64.37	0.37	4.52
'M2'	0.003	0.001	-0.003	0.001	103.35	60.43	194.00	54.46	0.36	37.30
'UPS1'	0.004	0.003	0.001	0.004	78.81	84.31	281.65	51.11	0.31	2.67
'N2'	0.003	0.001	-0.001	0.001	40.60	21.13	314.61	25.11	0.24	22.82
'MU2'	0.002	0.001	-0.002	0.001	127.53	94.69	226.91	74.13	0.14	16.07
'L2'	0.002	0.001	0.000	0.001	36.90	24.16	353.61	49.07	0.10	8.01
'M4'	0.002	0.001	-0.001	0.001	139.85	45.78	186.72	35.17	0.09	26.04
'SK3'	0.002	0.001	0.000	0.001	102.58	28.22	172.40	27.59	0.07	10.60
'MN4'	0.002	0.000	0.001	0.000	24.17	30.29	142.78	36.34	0.07	27.96
'S4'	0.002	0.001	0.000	0.001	93.40	25.05	249.26	18.40	0.06	17.35
'SN4'	0.001	0.000	0.001	0.001	95.47	61.89	49.75	63.01	0.05	17.03
'MK3'	0.001	0.001	0.000	0.001	85.05	35.55	297.76	39.01	0.04	6.91
'MS4'	0.001	0.000	0.001	0.000	54.89	62.86	134.16	67.79	0.04	14.49
'EPS2'	0.001	0.001	0.000	0.001	15.66	55.80	165.68	84.67	0.03	3.16
'M8'	0.001	0.000	0.000	0.000	161.82	20.22	266.37	13.56	0.03	25.21
'M6'	0.001	0.000	0.000	0.000	42.11	20.25	176.24	22.84	0.03	15.72
'2MN6'	0.001	0.000	0.000	0.000	70.86	31.62	146.12	33.57	0.02	13.58
'M3'	0.001	0.001	0.000	0.001	134.17	89.01	304.50	91.16	0.02	3.24
'2SK5'	0.001	0.000	0.000	0.000	125.07	29.11	202.59	32.96	0.01	7.62
'MO3'	0.001	0.001	0.000	0.001	10.09	135.93	337.48	315.20	0.01	2.64
'3MK7'	0.001	0.000	0.000	0.000	20.61	27.74	240.01	37.64	0.01	8.29
'2MK5'	0.001	0.000	0.000	0.000	153.83	71.89	171.80	67.38	0.01	4.55
'2MS6'	0.001	0.000	0.000	0.000	177.75	192.84	155.44	209.88	0.01	4.72
'2SM6'	0.000	0.000	0.000	0.000	1.83	155.99	162.22	187.31	0.00	3.22

Near-Surface Current

Table 6.Same as Table 5, but for near-surfaec currents.

Name	Lsmaj	Lsmaj_ci	Lsmin	Lsmin_ci	theta	theta_ci	g	g_ci	PE	SNR
'K1'	0.130	0.017	-0.075	0.017	27.10	14.78	147.56	15.69	52.93	148.24
'MSF'	0.093	0.058	0.004	0.039	138.91	20.40	23.14	44.46	20.42	6.79
MM'*	0.034	0.049	0.024	0.025	146.28	80.16	346.71	140.21	4.19	2.24
'OO1'	0.040	0.013	0.005	0.021	80.07	32.76	308.04	24.40	3.90	10.75
'O1'	0.041	0.017	0.002	0.017	25.50	25.71	216.39	24.69	3.89	10.69
'NO1'	0.035	0.015	-0.010	0.017	7.60	55.30	52.52	76.09	3.13	9.59
'Q1'	0.030	0.017	0.007	0.017	157.72	46.16	219.74	47.05	2.27	6.47
'UPS1'	0.030	0.019	-0.002	0.015	140.54	33.33	148.86	36.21	2.12	6.03
'J1'	0.026	0.014	0.010	0.015	111.89	50.02	303.79	53.51	1.85	6.91
'ALP1'	0.020	0.017	-0.001	0.018	56.98	61.25	276.02	57.89	0.97	2.58
'M2'	0.016	0.007	0.007	0.005	2.15	71.35	202.35	66.61	0.74	15.35
'2Q1'	0.017	0.017	0.002	0.016	34.20	76.26	33.42	85.26	0.71	2.11
'MU2'	0.011	0.007	-0.007	0.007	159.67	89.66	265.62	79.49	0.43	7.48
'EPS2'	0.013	0.006	-0.003	0.006	23.67	44.74	283.07	38.83	0.39	8.10
'MK3'	0.010	0.004	0.004	0.005	53.15	37.47	336.61	36.85	0.27	10.89
'S2'	0.010	0.006	0.000	0.007	120.32	44.06	203.50	45.92	0.22	4.27
'SK3'	0.008	0.004	0.004	0.005	74.02	57.94	150.35	49.62	0.19	7.23
'M3'	0.009	0.004	0.000	0.005	57.77	37.16	167.58	34.39	0.18	6.66
'ETA2'	0.007	0.006	-0.004	0.005	75.06	82.31	121.77	87.22	0.18	4.12
'N2'	0.008	0.005	0.001	0.007	176.98	165.45	270.56	224.61	0.14	3.17
'L2'	0.007	0.006	0.003	0.006	4.06	176.87	348.13	274.54	0.12	2.90
'S4'	0.007	0.004	-0.003	0.003	158.93	41.89	196.16	57.41	0.12	8.71
'MO3'	0.005	0.004	0.005	0.004	6.09	159.86	280.19	269.60	0.11	5.08
'M4'	0.006	0.004	0.003	0.003	99.42	66.30	210.34	66.53	0.11	8.34
'2MK5'	0.004	0.002	-0.002	0.002	24.01	84.50	350.27	132.52	0.06	12.62
'SN4'	0.005	0.004	-0.001	0.003	148.24	51.02	26.38	78.14	0.06	3.79
'M6'	0.004	0.003	0.000	0.002	126.38	29.40	318.11	39.37	0.05	5.02
'MN4'	0.004	0.004	-0.001	0.003	170.07	78.17	151.90	139.30	0.05	3.28
'2MS6'	0.004	0.002	0.002	0.002	106.63	62.91	15.75	135.78	0.05	8.23
'MS4'	0.004	0.003	0.002	0.003	61.20	93.02	316.89	80.80	0.04	3.60
'M8'	0.004	0.002	0.000	0.002	4.72	59.77	27.01	93.10	0.04	8.37
'2SK5'	0.004	0.002	0.001	0.002	96.91	35.46	177.67	48.52	0.04	7.11
'2MN6'	0.003	0.003	0.001	0.002	127.55	48.91	168.21	69.90	0.02	3.37
'2SM6'	0.002	0.002	-0.001	0.002	71.94	94.92	260.92	102.26	0.01	2.06
'3MK7'	0.002	0.001	-0.001	0.001	134.89	82.49	312.23	122.37	0.01	4.77

Mid-Depth Current

Table 7. Same as Table 5, but for mid-depth currents.

Name	Lsmaj	Lsmaj_ci	Lsmin	Lsmin_ci	theta	theta_ci	g	g_ci	PE	SNR
'MSF'	0.050	0.084	0.011	0.028	36.88	22.25	26.80	143.88	37.95	1.29
'K1'	0.033	0.009	-0.027	0.008	13.52	56.60	287.55	64.94	26.22	49.00
MM'*	0.022	0.078	0.000	0.032	72.66	30.49	51.52	168.82	7.12	0.27
'2Q1'	0.015	0.009	-0.009	0.008	2.63	203.85	14.38	228.74	4.19	8.41
'OO1'	0.016	0.008	-0.002	0.009	77.96	39.87	72.04	32.36	3.96	7.33
'O1'	0.014	0.008	-0.008	0.008	161.15	72.52	158.85	85.39	3.91	7.77
'UPS1'	0.014	0.008	-0.004	0.008	59.42	42.32	220.68	44.75	2.97	5.94
'J1'	0.011	0.007	-0.007	0.008	49.93	86.95	302.04	83.21	2.46	5.88
'ALP1'	0.013	0.010	0.003	0.007	4.12	106.01	341.35	411.02	2.43	4.61
'S2'	0.009	0.004	-0.008	0.003	10.53	149.94	252.30	162.70	2.02	25.33
'MU2'	0.009	0.003	-0.004	0.004	129.68	33.52	124.23	33.06	1.39	13.55
'N2'	0.009	0.004	-0.002	0.003	35.94	31.10	294.58	27.21	1.18	12.32
'Q1'	0.007	0.007	0.000	0.007	10.01	94.84	129.84	133.11	0.79	2.08
'M2'	0.006	0.003	-0.003	0.004	167.66	81.30	190.83	68.01	0.65	7.24
'L2'	0.005	0.004	-0.003	0.003	79.69	77.19	309.87	87.35	0.52	6.69
'ETA2'	0.004	0.004	-0.001	0.003	132.38	76.93	187.03	69.80	0.30	3.47
NO1'*	0.004	0.008	0.001	0.006	132.83	138.38	110.59	156.51	0.23	0.64
'S4'	0.003	0.002	0.000	0.002	131.19	43.32	273.23	43.99	0.17	5.60
'MK3'	0.003	0.002	-0.002	0.002	78.55	91.61	311.70	82.01	0.16	6.19
'EPS2'	0.003	0.003	0.001	0.002	79.48	81.62	239.02	95.22	0.15	2.78
'SN4'	0.003	0.002	-0.001	0.002	173.19	130.35	80.09	188.18	0.14	5.00
'SK3'	0.003	0.002	0.001	0.002	108.84	68.91	165.08	48.48	0.14	5.61
'M6'	0.003	0.001	0.001	0.001	52.11	30.41	121.08	35.28	0.14	11.48
'MO3'	0.003	0.002	0.002	0.001	31.61	49.15	312.31	99.20	0.13	5.70
'M4'	0.003	0.002	0.000	0.002	52.23	55.08	343.62	90.40	0.11	4.52
'M3'	0.002	0.001	-0.001	0.002	133.42	82.28	324.42	51.04	0.11	5.52
'2MN6'	0.002	0.001	-0.001	0.001	58.14	55.97	134.97	60.33	0.10	11.61
'MN4'	0.002	0.002	0.001	0.002	40.69	84.70	126.95	96.61	0.10	3.18
'MS4'	0.002	0.002	0.000	0.002	105.29	71.39	136.43	58.04	0.07	2.53
'2MS6'	0.002	0.001	-0.001	0.001	154.83	50.51	85.60	46.99	0.06	6.55
'2SK5'	0.002	0.001	-0.001	0.001	150.39	100.13	140.83	78.24	0.05	4.42
'M8'	0.001	0.001	-0.001	0.001	23.76	106.71	56.23	132.26	0.04	9.30
'2MK5'	0.002	0.001	0.000	0.001	135.91	80.10	114.31	46.48	0.04	2.70
3MK7'*	0.001	0.001	0.000	0.001	56.96	107.29	51.00	138.86	0.02	1.65
2SM6'*	0.001	0.001	0.000	0.001	15.40	113.02	170.43	183.22	0.01	1.07

Near-Bottom Current

Table 8. Same as Table 5, but for near-bottom currents.

Name	Lsmaj	Lsmaj_ci	Lsmin	Lsmin_ci	theta	theta_ci	g	g_ci	PE	SNR
'MSF'	0.046	0.038	-0.001	0.011	22.27	8.46	340.82	74.22	50.17	5.39
'MM'	0.029	0.037	0.001	0.004	32.48	8.36	288.01	73.29	19.83	2.38
'K1'	0.012	0.004	-0.006	0.004	116.72	27.97	332.24	26.09	4.50	26.41
OO1'*	0.012	0.004	-0.005	0.004	121.25	27.53	134.49	23.35	3.62	23.55
'O1'	0.011	0.002	0.004	0.004	171.90	32.80	225.90	21.56	2.88	24.41
'J1'	0.010	0.004	-0.002	0.003	124.73	25.92	146.21	22.00	2.39	15.55
'ALP1'	0.009	0.002	0.001	0.004	159.07	24.38	245.52	15.74	1.72	14.82
'ETA2'	0.008	0.002	0.001	0.004	175.22	56.81	7.91	473.40	1.68	15.93
'S2'	0.008	0.003	-0.002	0.005	175.66	74.10	216.04	56.45	1.60	8.57
'2Q1'	0.008	0.002	-0.001	0.004	170.90	48.64	28.79	32.94	1.55	12.87
'Q1'	0.007	0.003	-0.002	0.003	46.11	21.11	351.73	43.46	1.41	16.50
'NO1'	0.006	0.002	-0.002	0.002	139.48	20.50	51.80	15.76	0.98	25.65
'M2'	0.006	0.005	-0.002	0.003	86.39	32.04	296.75	55.15	0.93	5.32
'UPS1'	0.006	0.003	-0.002	0.004	133.14	55.96	45.04	40.91	0.87	6.58
'N2'	0.006	0.003	-0.002	0.004	176.91	194.93	12.06	271.45	0.79	5.55
'MU2'	0.005	0.001	-0.003	0.002	130.96	51.50	259.05	52.69	0.75	27.11
'L2'	0.006	0.003	0.001	0.003	47.56	31.47	197.41	44.52	0.75	7.39
'M4'	0.004	0.002	-0.002	0.002	145.12	31.92	204.33	31.84	0.49	8.84
'SK3'	0.004	0.001	0.000	0.001	80.50	12.43	131.84	16.91	0.37	33.32
'MN4'	0.004	0.002	0.000	0.003	27.74	56.55	197.67	60.42	0.30	3.39
'S4'	0.004	0.002	0.001	0.002	105.10	32.42	79.36	33.86	0.30	6.79
'SN4'	0.003	0.002	-0.001	0.002	130.62	39.51	237.33	30.30	0.28	7.67
'MK3'	0.003	0.003	0.000	0.002	88.54	34.82	186.62	76.24	0.26	3.15
'MS4'	0.003	0.001	0.002	0.001	18.18	78.68	96.30	64.55	0.23	17.97
'EPS2'	0.003	0.001	-0.001	0.002	6.08	126.25	132.82	104.49	0.23	5.99
'M8'	0.003	0.001	0.001	0.001	115.18	30.20	342.12	23.26	0.20	16.27
'M6'	0.003	0.001	0.000	0.001	141.26	26.77	165.75	16.91	0.18	13.14
'2MN6'	0.003	0.002	0.000	0.001	96.01	22.09	260.24	35.93	0.16	7.72
'M3'	0.002	0.001	-0.001	0.002	98.28	65.26	139.25	62.29	0.15	5.12
'2SK5'	0.002	0.002	-0.001	0.002	143.46	66.34	260.58	56.68	0.14	3.93
'MO3'	0.002	0.002	0.000	0.002	158.04	90.08	235.12	91.88	0.09	2.63
'3MK7'	0.002	0.001	0.000	0.001	142.67	43.96	208.48	37.62	0.06	6.99
'2MK5'	0.001	0.002	0.000	0.002	44.91	68.02	352.28	362.28	0.05	0.95
'2MS6'	0.001	0.001	0.000	0.001	76.70	45.98	357.34	165.08	0.04	3.55
'2SM6'	0.001	0.001	-0.001	0.001	78.53	59.13	30.24	88.30	0.04	3.46

Tidal Ellipses

Tables 5-8 include the semi-major axis, semi-minor axis, and orientation of the individual tidal constituents from the harmonic analysis. Figure 10 shows the variance ellipses of the harmonically generated currents over the observation time period for the barotropic, near-surface, mid-depth, and near-bottom currents.

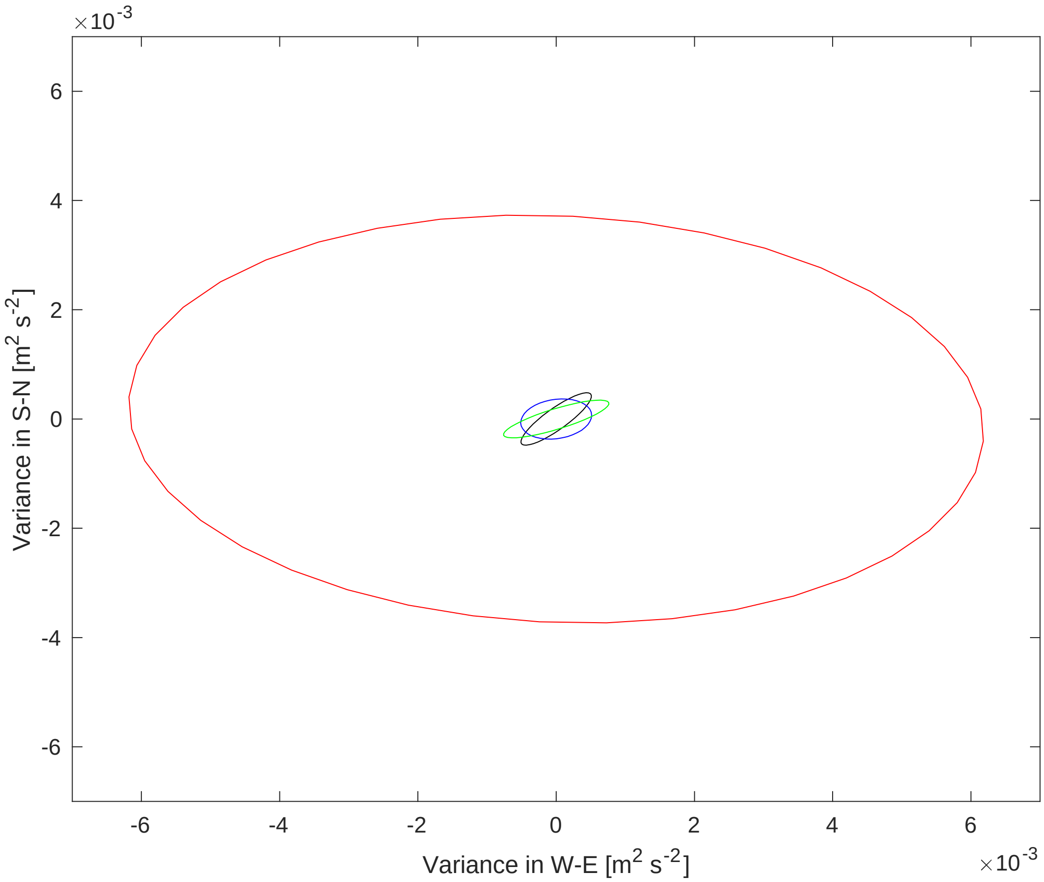


Figure 10. Variance ellipses for harmonically reconstructed tides for the barotropic flow (black), near-surface flow (red), mid-depth flow (blue) and bottom flow (green).

Included Files

The files included are listed in Table

Filename	Description
_RDI_001.000	Teledyne/RDI binary file
u.dat	Ascii file of u [mm/s], bad data -9999, Ensemble (11974)x bin (48)
v.dat	Ascii file of v [mm/s], bad data -9999, Ensemble (11974)x bin (48)
uBT.dat	Ascii file of barotropic u [mm/s], bad data -9999, Ensemble (11974)x 1
vBT.dat	Ascii file of barotopic v [mm/s], bad data -9999, Ensemble (11974)x 1
uSurf.dat	Ascii file of near-surf u [mm/s], bad data -9999, Ensemble (11974)x 1
vSurf.dat	Ascii file of near-surface v [mm/s], bad data -9999, Ensemble (11974)x 1
uMid.dat	Ascii file of mid-depth u [mm/s], bad data -9999, Ensemble (11974)x 1
vMid.dat	Ascii file of mid-depth v [mm/s], bad data -9999, Ensemble (11974)x 1
uBot.dat	Ascii file of near-bottom u [mm/s], bad data -9999, Ensemble (11974)x 1
vBot.dat	Ascii file of near-bottom v [mm/s], bad data -9999, Ensemble (11974)x 1
datetime.dat	Ascii file of YYYY MM DD hh mm ss for each ensemble

References

[1] NOAA IOOS (2019), Manual for Real-Time Quality Control of In-Situ Current Observations, V2.1, doi: 10.25923/sqe9-e310

[2] Daniel Pereira (2022). Wind Rose (https://www.mathworks.com/matlabcentral/fileexchange/47248-wind-rose), MATLAB Central File Exchange. Retrieved February 13, 2022.

[3] Codiga, D. L. (2011). Unified tidal analysis and prediction using the UTide Matlab functions.

Appendix F:

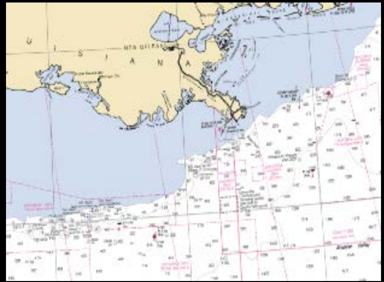
Escambia County Confirmation

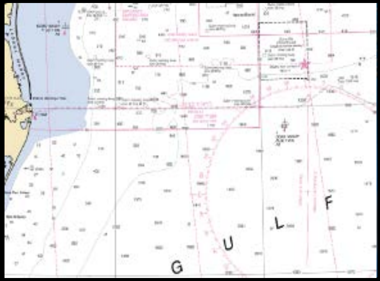
From:	Kelly Lucas
To:	Robert K Turpin
Cc:	Andrews, Stephen W Jr CIV USARMY CESAJ (US
Subject:	information needed
Date:	Wednesday, August 14, 2019 8:55:00 AM
Attachments:	Manna Gulf Project Precision Siting 02AUG2019.pdf

Hi Robert,
I got your voicemail. Thanks so much for pinging the higher ups. I think we will be good with an email to me and Steve Andrews that state that you all are ok with the finfish farm permit area being 500ft from the artificial reef permit area. I attached the presentation to refresh that is only the NW corner that is that close. I copied Steve just in case he think we need something more than an email confirmation.

Thanks for your help.
Kelly

Kelly Lucas, Ph.D.
Director
Thad Cochran Marine Aquaculture Center
School of Ocean Science and Engineering
University of Southern Mississippi
Mail: 703 East Beach Dr. Ocean Springs, MS. 39564
Phone: 228-818-8026

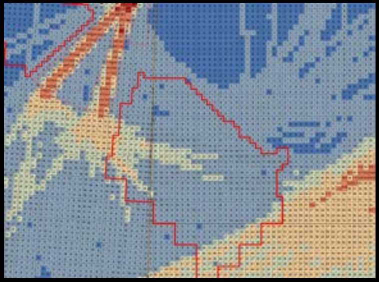


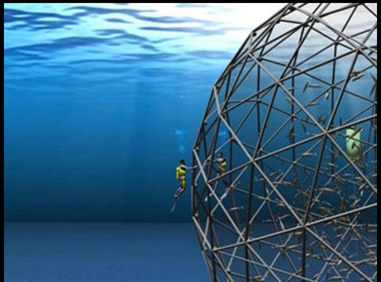


PRECISION SITING ANALYSIS FOR MANNA OFFSHORE AQUACULTURE DEMONSTRATION PROJECT

Kenneth Riley, Lisa Wickliffe, Jonathan Jossart, and James A. Morris, Jr.

NOAA National Ocean Service
National Centers for Coastal Ocean Science
Ken.Riley@noaa.gov



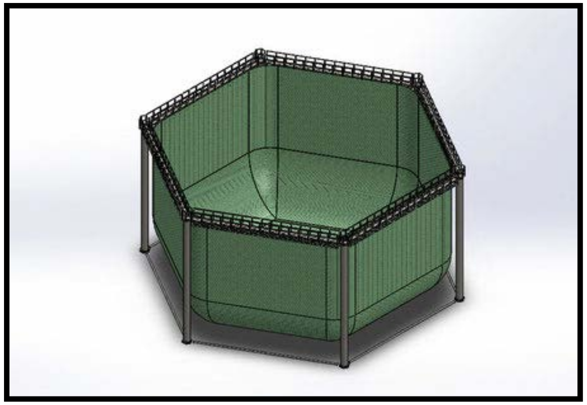


Manna Fish Farms Offshore Demonstration Project

MANNA FISH FARMS, INC.

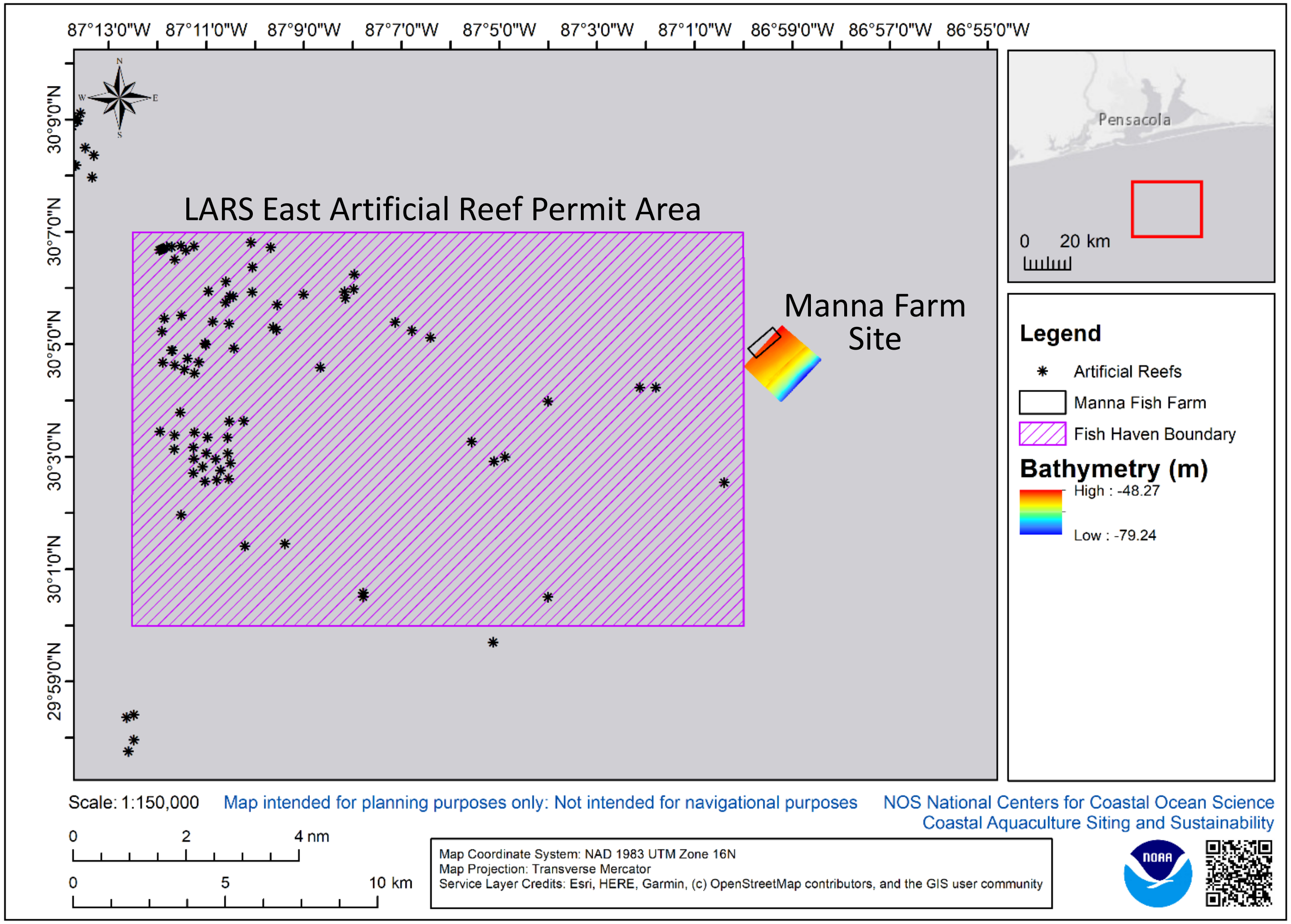
STORM SAFE Submersible Cage System

- Commercial-scale aquaculture demonstration project
- Area of interest: Mississippi, Alabama, Florida panhandle
- Species: Red drum (*Sciaenops ocellatus*) and other native species
- Area: 120 acres (0.49 sq km)
- Depth requirements: 50 – 55 meters
- Partnerships: University of Southern Mississippi, University of New Hampshire, National Sea Grant Law Center, NOAA



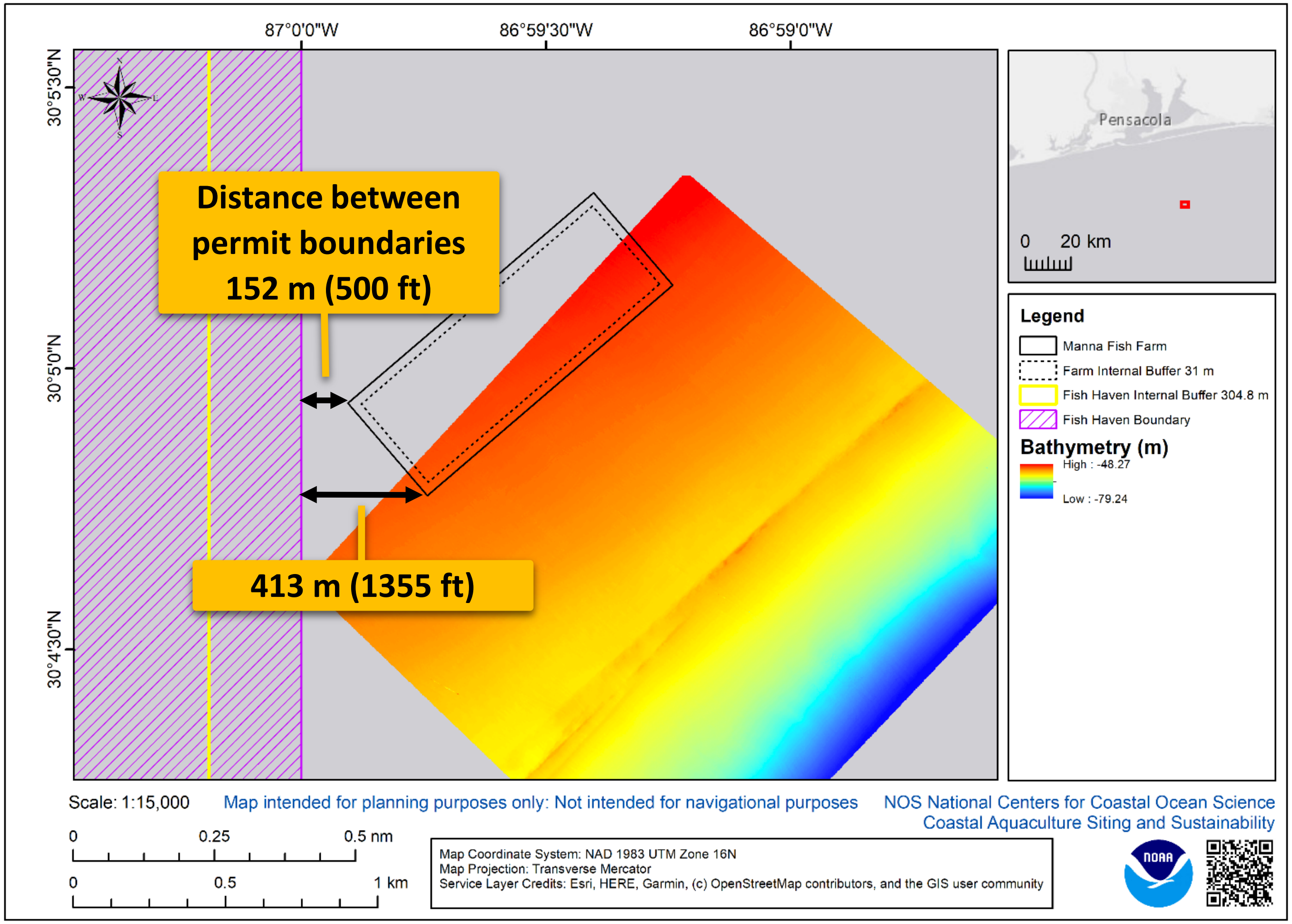
Manna Farm Location

The 105-acre site is located 30 km (16 nm) offshore adjacent to LARS East Artificial Reef



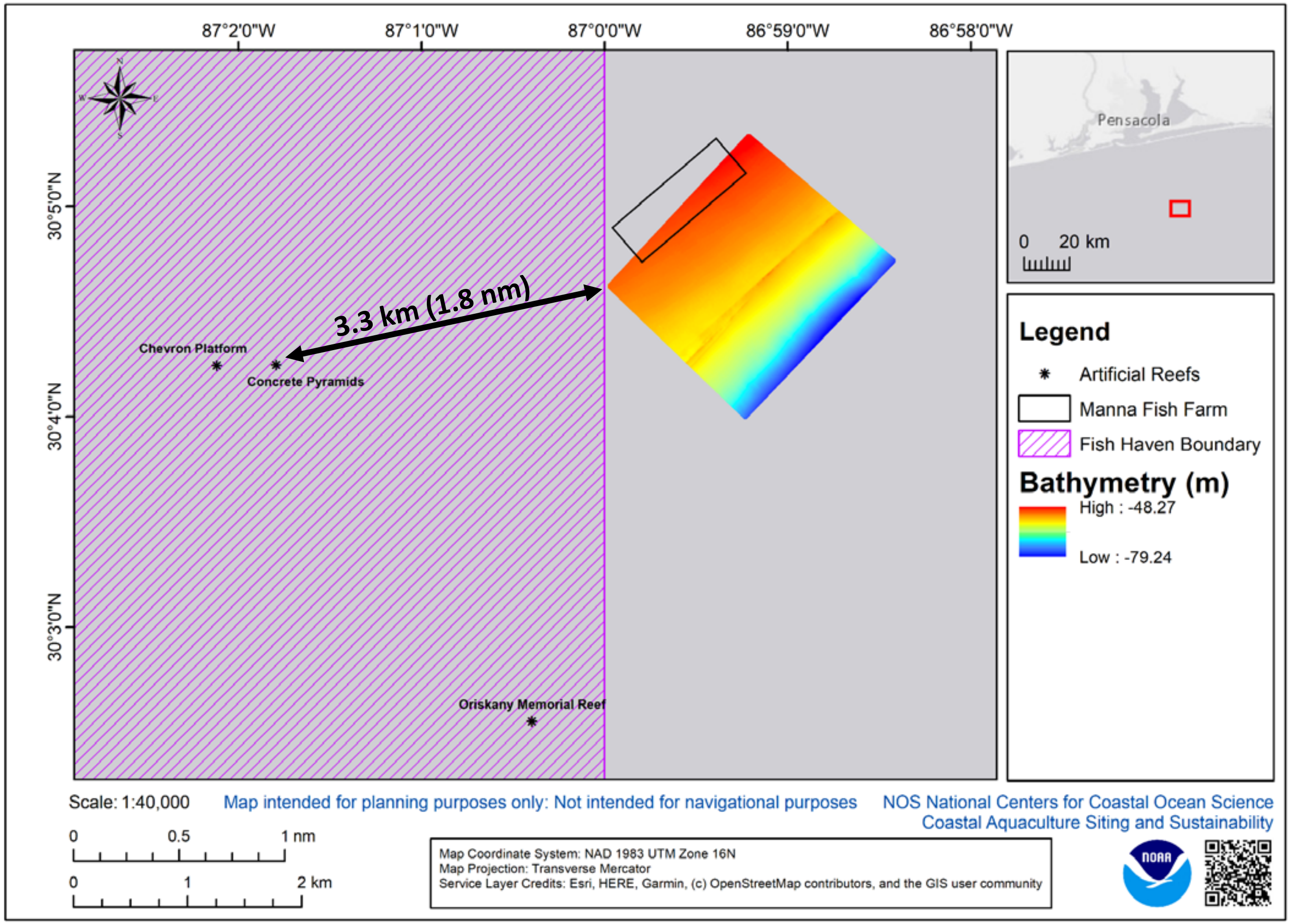
Manna Farm Location

Location of the 105-acre farm site in relation to LARS East Artificial Reef permit boundary



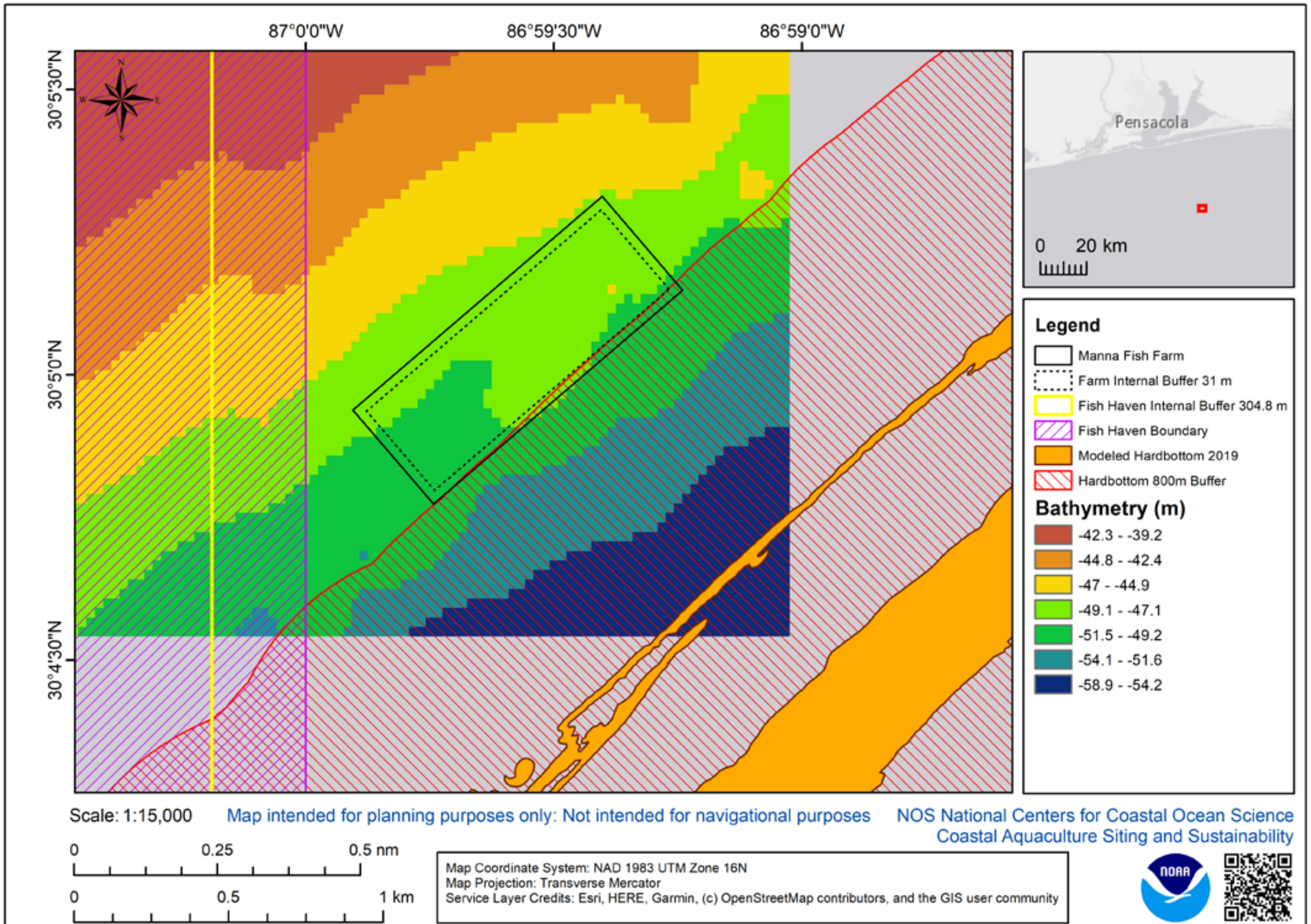
Manna Farm Location

Closest artificial reef materials are concrete pyramids located 3.1 km (1.7 nm) from farm perimeter



Manna Farm Location

Farm boundary is 152 m (500 ft) from artificial reef boundary



Proposed location maintains approximately 800 m (2,625 ft) buffer from potential hardbottom habitat

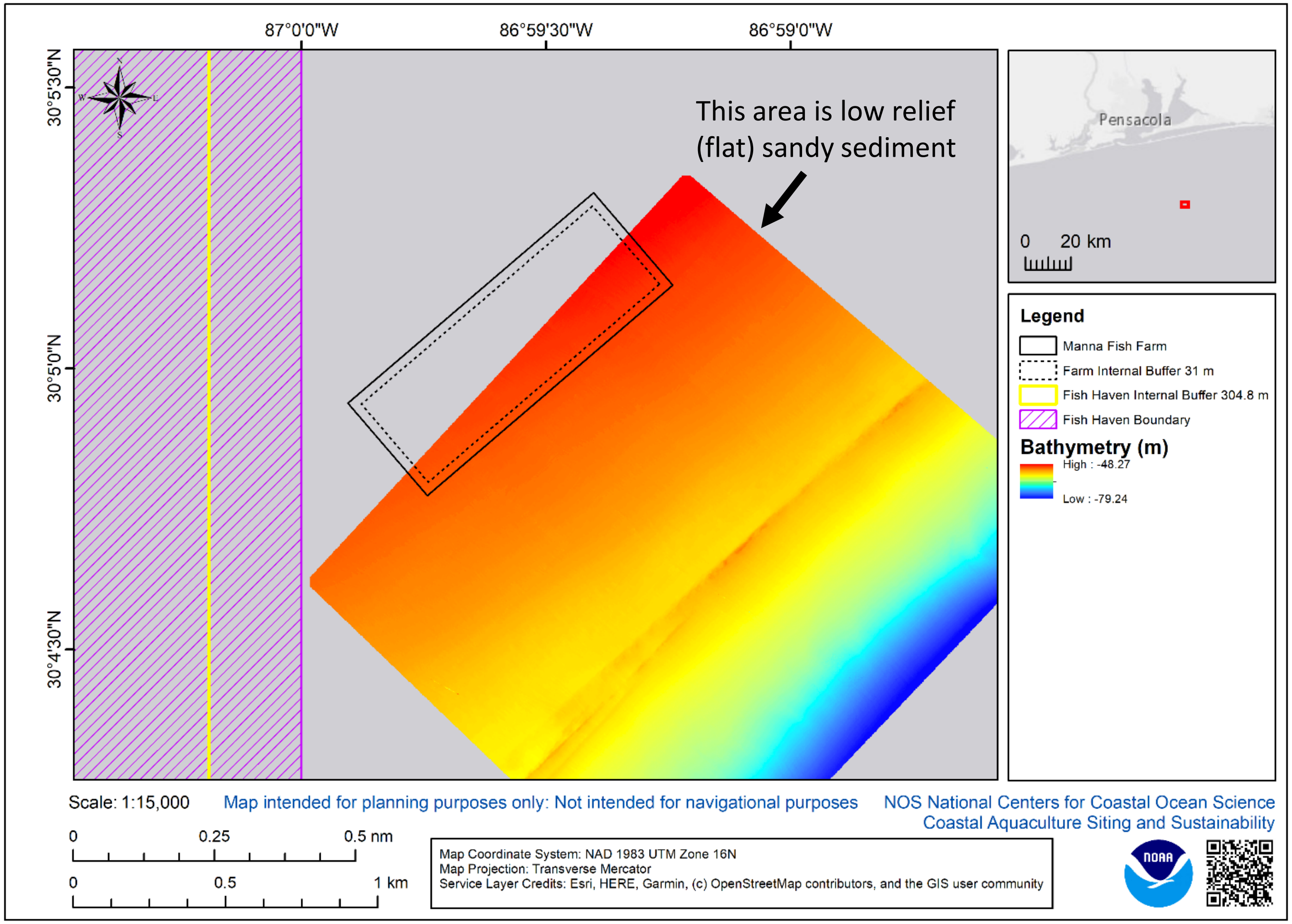
Depths across the farm site range from 47 to 52 m (154 to 171 ft)

Map includes 304.8-m (1000 ft) buffer inside artificial reef boundary designating footprint of reef materials that could be constructed in future

Map includes 31-m (100 ft) buffer inside farm boundary designating extent of where anchors could be installed

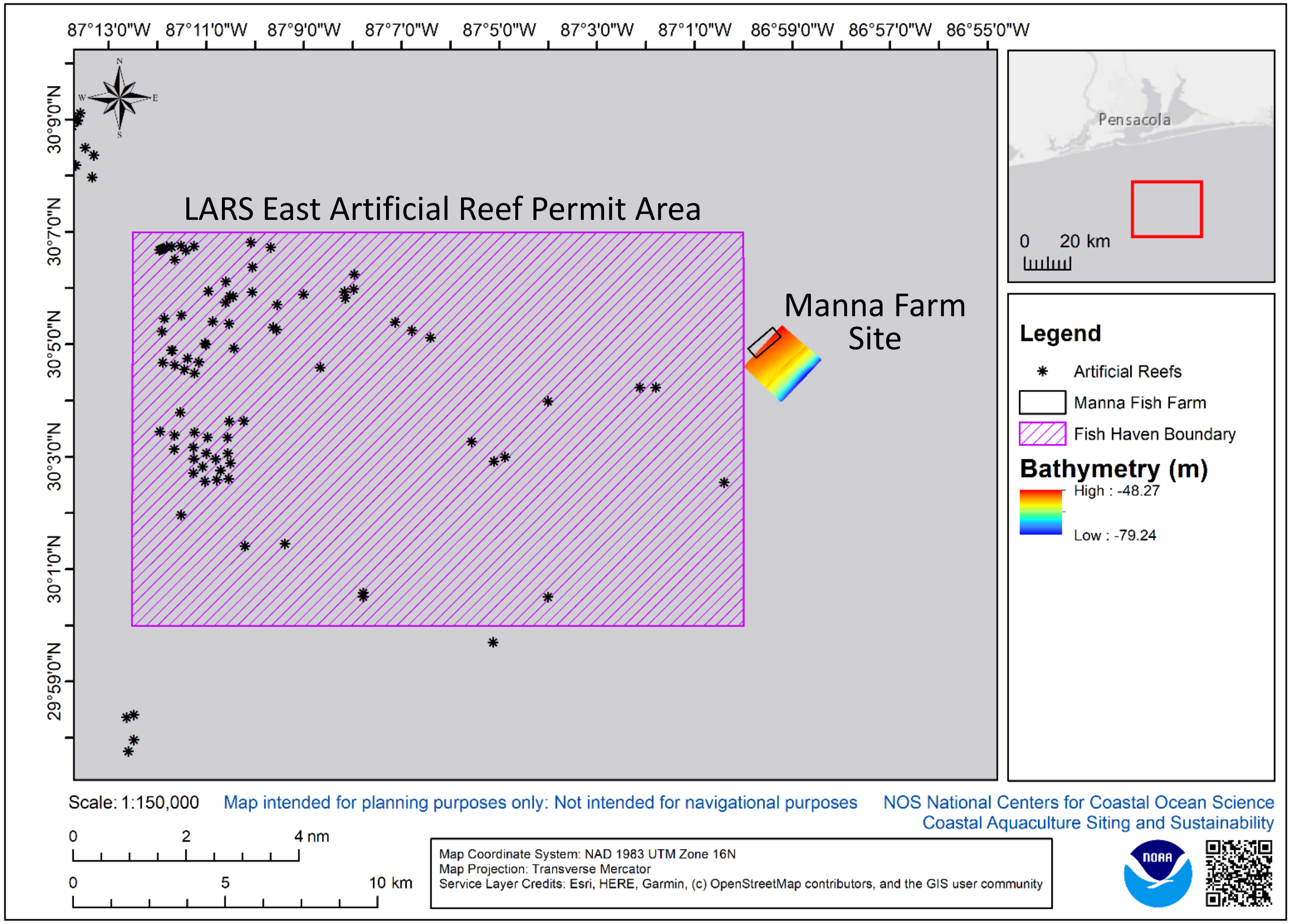
Manna Farm Location

Location of the 105-acre farm site in relation to University of Southern Mississippi baseline environmental survey (May 2019)



Manna Farm Coordinates

Latitude	Longitude
30.08580800	-86.98734600
30.07957000	-86.99571400
30.08231100	-86.99841500
30.08854900	-86.99004800



Questions?

Contact: Dr. Kenneth Riley
NOAA Coastal Aquaculture Siting and Sustainability
Email: ken.riley@noaa.gov
252-728-8750

From: Robert K Turpin
To: Kelly Lucas
Cc: Andrews, Stephen W Jr CIV USARMY CESAJ (US; Timothy R. Day
Subject: Re: Checking in on FinFish Farm Question
Date: Tuesday, August 13, 2019 10:03:55 PM

Dr Lucas, I have been authorized by Interim Assistant County Administrator Taylor Kirschenfeld to notify all concerned that Escambia County does not object to the proposed anchoring of the mariculture facility.
Regards,
Robert Turpin, Manager
Escambia County Marine Resources Division
Cell 850-554-5869

From: Kelly Lucas <Kelly.Lucas@usm.edu>
Sent: Thursday, August 8, 2019 9:10:47 AM
To: Robert K Turpin <RKTURPIN@myescambia.com>
Cc: Andrews, Stephen W Jr CIV USARMY CESAJ (US <Stephen.W.Andrews@usace.army.mil>; Timothy R. Day <TRDAY@myescambia.com>
Subject: Checking in on FinFish Farm Question

Hi Robert,
I am checking in to see if you have an answer regarding the finfish farm distance from the artificial reef area. We know we will need to re-survey the area around the new farm footprint and before we can plan that survey we need an answer from you team.

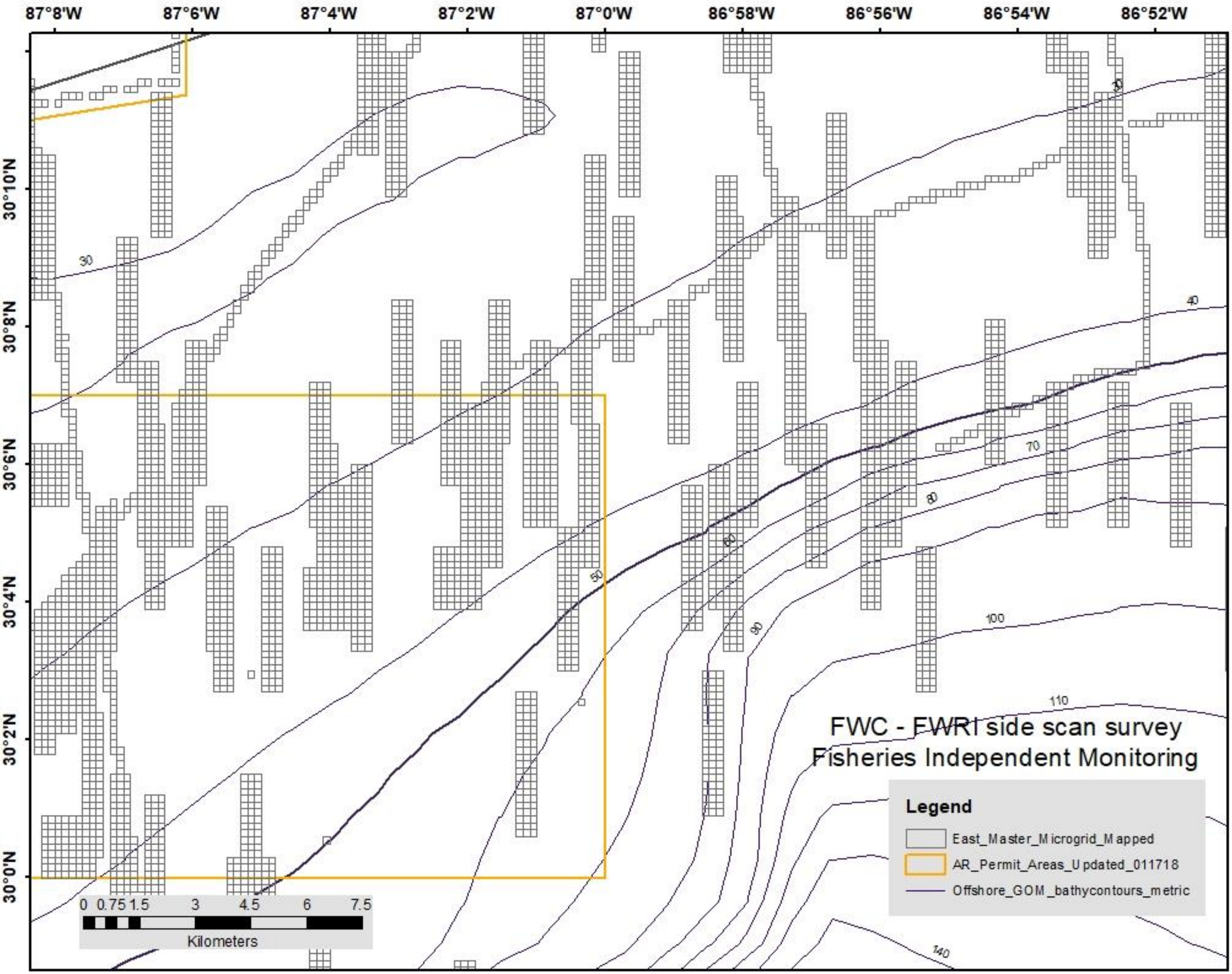
Please let me know where you are in the process or if you need additional information.

Thanks,
Kelly

Kelly Lucas, Ph.D.
Director
Thad Cochran Marine Aquaculture Center
School of Ocean Science and Engineering
University of Southern Mississippi
Mail: 703 East Beach Dr. Ocean Springs, MS. 39564
Phone: 228-818-8026

Appendix G:

Artificial Reef Survey Coverage



87°8'W
87°6'W
87°4'W
87°2'W
87°0'W
86°58'W
86°56'W
86°54'W
86°52'W
30°10'N
30°8'N
30°6'N
30°4'N
30°2'N
30°0'N
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90
100
110
140
FWC - FWRI side scan survey
Fisheries Independent Monitoring
Legend
East_Master_Microgrid_Mapped
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Offshore_GOM_bathycontours_metric
0 0.75 1.5 3 4.5 6 7.5
Kilometers

Appendix H:

2nd Baseline Environmental Survey Report (2020)

Baseline Environmental Survey

Manna Fish Farms Offshore Aquaculture Site – Gulf of Mexico

University of Southern Mississippi

DAVID EVANS AND ASSOCIATES INC.

Baseline Environmental Survey

Manna Fish Farms Offshore Aquaculture Site - Gulf of Mexico

Project Report

July 2021

Prepared for

Prepared by

David Evans and Associates, Inc.
14231 Seaway Road, Suite 4002
Gulfport MS 39503

Recon Offshore, Inc.
P.O. Box 30210
Pensacola FL 32503

Baseline Environmental Survey
Manna Fish Farms Offshore Aquaculture Site - Gulf of Mexico

Project Report
July 2021

Prepared by

Tim McClinton, Ph.D., P.G., GISP
Senior Geophysicist and Project Manager
Senior Associate
tmcclinton@deainc.com

Reviewed by

Jon Dasler, P.E., P.L.S., C.H.
Quality Manager
Director of Marine Services / Senior Vice President
jld@deainc.com

Baseline Environmental Survey

Manna Fish Farms Offshore Aquaculture Site - Gulf of Mexico

Project Report

July 2021

Cultural Resources Review by

Jason Burns, M.A., RPA
Principal and Maritime Archaeologist
RECON Offshore, Inc.
jason.burns@reconoffshore.com

Table of Contents

Separates

1.0 Introduction

David Evans and Associates, Inc. (DEA) was contracted by University of Southern Mississippi (USM) to conduct a hydrographic and geophysical survey of a site offshore Pensacola, FL. The objective of the survey was to acquire baseline environmental data to support siting and permitting of a proposed Manna Fish Farms offshore aquaculture facility in accordance with federal guidelines and the National Oceanic and Atmospheric Administration (NOAA) and Environmental Protection Agency (EPA) document "Baseline Environmental Survey Guidance and Procedures for Marine Aquaculture Activities in U.S. Federal Waters of the Gulf of Mexico", dated 24 October 2016. DEA conducted survey operations from 7-11 December 2020 utilizing multibeam sonar and a towed array consisting of a combined side scan sonar, subbottom profiler, and magnetometer. Data processing and analysis has yielded a bathymetric map (proposed aquaculture sites only), a side scan image mosaic with seafloor contacts, subbottom profiles with subseafloor contacts, and magnetic field data with magnetic anomalies. The processed data and features of interest have been reviewed by maritime archaeologists at RECON Offshore, Inc. (RECON). This report describes the fieldwork, data processing, quality control procedures, and results for this project.

2.0 Survey Area

The survey area was located approximately 30 kilometers (km) south of Pensacola Beach, FL in the Gulf of Mexico (Figure 1). The survey area encompassed three proposed aquaculture sites enclosed by a 1000-meter (m) buffer to the northwest, north, and northeast (Figure 2). The buffer was truncated to the south by the boundary of a previously surveyed site and truncated to the west by the boundary of a fish management area. Charted depths in the survey area ranged between 35-55m mean lower low water (MLLW).

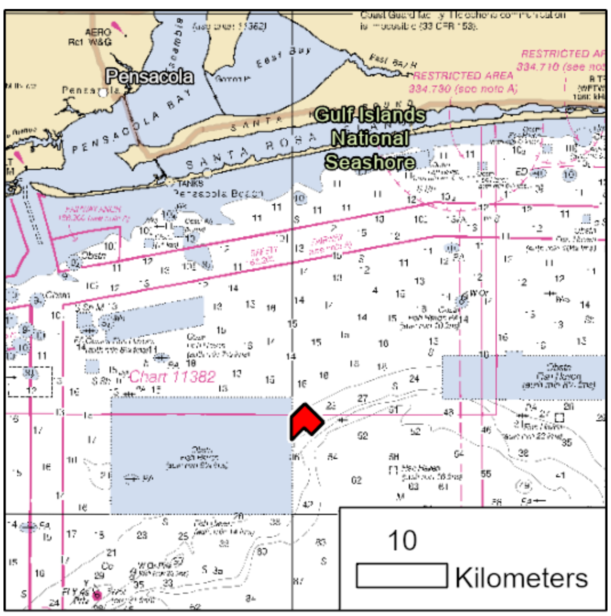

Figure 1 Overview map with survey area indicated in red. Background is NOAA chart 11360 with depths shown in fathoms relative to mean lower low water (MLLW).

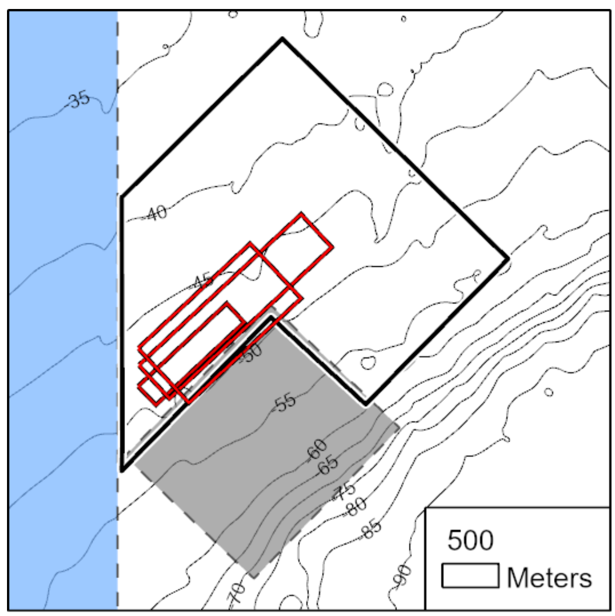

Figure 2 Detail map with survey area outlined in black. Proposed aquaculture sites are outlined in red. The previously surveyed site to the south is shaded grey. The fish management area to the west is shaded in blue. Depth contours derived from regional bathymetry are in meters relative to MLLW.

3.0 Survey Vessel and Equipment

3.1 Survey Vessel

DEA's survey vessel *Blake*, homeported in Gulfport, MS, was used for this project. The *Blake* is a custom-built aluminum catamaran with an overall length of 25m, a beam of 8.25m, and a draft of approximately 1.4m. The vessel is designed for safe, efficient 24-hour offshore survey operations with a complement of 10 including 4 vessel crew and 4-6 survey crew. The *Blake* is equipped with a hydraulic strut and moonpool for deploying a multibeam sonar, a hydraulic articulating A-frame and oceanographic winch for deploying and towing survey equipment, and hydraulic knuckle boom cranes at the bow and amidships for maneuvering and/or deploying equipment. The *Blake*'s propulsion chain consists of twin 800-horsepower Tier-3 Caterpillar C18 diesel engines with ZF 500 reduction gears and ZF four-blade screws.

3.2 Hydrographic Survey Equipment

The *Blake* was equipped with a Teledyne-Reson SeaBat T50-R multibeam sonar. The T50-R is a wide-band sonar capable of operating at frequencies between 190-420 kiloHertz (kHz) with a maximum swath coverage of 140 degrees and up to 512 beams. The T50-R was deployed through the *Blake*'s amidships moonpool by lowering the sonar with a hydraulic actuated sonar strut. An AML moving vessel profiler MVP30-350 was used to acquire sound velocity profiles of the water column while underway. In addition, an AML MicroSV sound speed probe was mounted at the T50-R sonar head to acquire near-surface sound velocity profiles for real-time input directly to the T50-R sonar processing system to enable proper beamforming.

3.3 Geophysical Survey Equipment

For this project the *Blake* was equipped with an EdgeTech 2000-DSS system. The 2000-DSS is an integrated side scan and subbottom profiling system that combines a dual-frequency (100kHz/600kHz) side scan sonar with a 2-16kHz subbottom profiler in a single towfish. The towfish is equipped with pitch, heading, and roll sensors and a pressure sensor for determining towfish depth. A Marine Magnetics SeaSpy magnetometer was used to acquire magnetic field data. The 2000-DSS and SeaSpy were deployed with the *Blake*'s hydraulic A-frame and towed astern of the *Blake*. The SeaSpy was tethered to the 2000-DSS, forming a composite array which simultaneously acquired side scan imagery, subbottom profiles, and magnetic field data with the same tow cable. The altitude of the array above the seafloor was monitored and adjusted using the *Blake*'s hydraulic winch and electronic cable counter. The cable counter was configured to send cable out readings directly to data acquisition software such that an accurate layback position could be calculated in real time for the towed geophysical array. The cable counter was calibrated prior to the survey and periodically referenced against known marks on the tow cable.

3.4 Positioning and Motion Reference Systems

The primary positioning system was an Applanix Position and Orientation System for Marine Vessels (POS/MV) 320 (Version 5) integrated global navigation satellite system (GNSS) and inertial reference system. The system consisted of an inertial motion unit (IMU), dual-frequency GNSS antennas, and a processing computer. The POS/MV provided complete time synchronization of the sonar, position, heading, motion, and timing data, which were output directly to data acquisition software on the data acquisition computers. The POS/MV was configured to log the raw observable groups required for postprocessing the real-time sensor data. Backup positioning was provided by a Trimble SPS-855 GNSS receiver.

3.5 Data Acquisition Systems

The hydrographic data acquisition systems aboard the *Blake* consisted of multiple stations with Windows computers running Hypack software, Teledyne-Reson SeaBat sonar software, and DEA's proprietary LineLog software for recording acquisition settings, environmental conditions, and survey notes. The geophysical data acquisition stations included multiple computers running Hypack software, EdgeTech Discover software, SeaLINK magnetometer software, and DEA's LineLog software. All data acquisition systems were synced to Coordinated Universal Time (UTC).

4.0 Survey Operations

4.1 Coverage Requirements

Survey coverage requirements varied within the survey area. 100% side scan coverage was required for the entire survey area (approximately 14km^2), while 100% multibeam coverage was required only within the boundary of the proposed aquaculture sites (approximately 1.7km^2). Based on a review of charted water depths within the survey area, and in consultation with USM and NOAA/EPA baseline environmental survey requirements, DEA designed a survey plan in which the multibeam bathymetry data would be acquired first with an estimated line spacing of 40-50m, with final line spacing dependent on multibeam sonar swath width as a function of depth. After completing multibeam data acquisition, the geophysical data (side scan, subbottom profiler, and magnetometer) would be acquired with a line spacing of 50m and a cross line spacing of 200m (Figure 3). Side scan sonar imagery, subbottom profiles, and magnetic field data would be acquired simultaneously utilizing the EdgeTech 2000-DSS with tethered magnetometer.

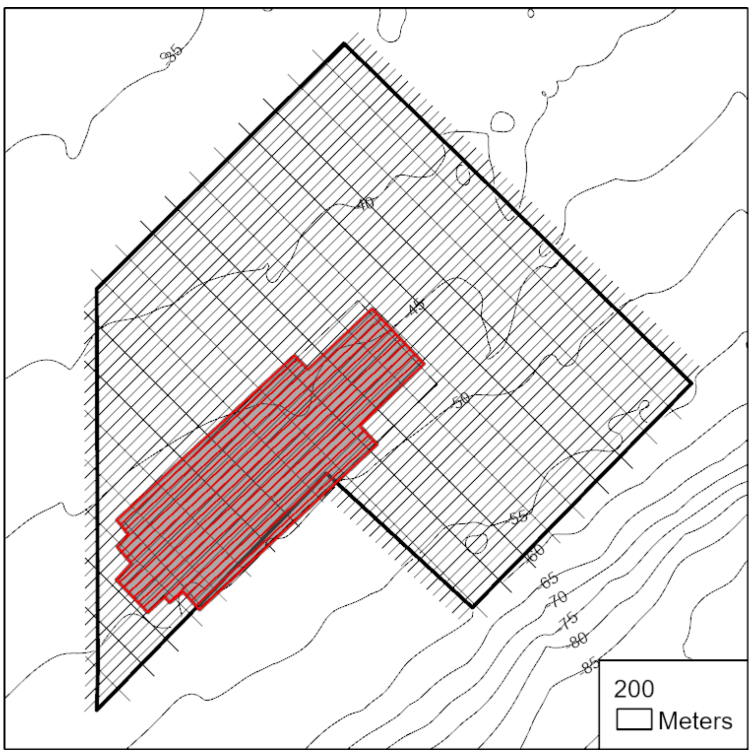

Figure 3 Survey line plan designed by DEA in consultation with USM and NOAA/EPA guidelines. Black polygon encloses survey area (~14km^2) requiring 100% side scan coverage; red polygon encloses proposed aquaculture sites (~1.7km^2) requiring 100% multibeam coverage. Multibeam survey line spacing (red) is 40-50m. Geophysical survey line spacing (grey) is 50m with cross line spacing of 200m. Depth contours derived from regional bathymetry are in meters relative to MLLW.

4.2 Datums, Survey Control, and Positioning

The horizontal datum for this survey is the North American Datum of 1983 (NAD83), Universal Transverse Mercator (UTM) Zone 16 North. Horizontal units are in meters. Primary horizontal positions were acquired with the Applanix POS/MV which received Wide Area Augmentation System (WAAS) corrections for real-time positioning during data acquisition. The POS/MV provided complete time synchronization of the position, heading, motion, timing, and sonar data and output these data directly to Hypack and Discover data acquisition software. Raw POSPAC data from the POS/MV were logged to enable post-processing of attitude and navigation data. Post-processing was conducted using a single base solution in Applanix POSPAC software.

The vertical datum for this survey is Mean Lower Low Water (MLLW) with vertical units in meters. All multibeam bathymetric data were time-tagged and recorded relative to the vertical reference point of the *Blake*. Using a fixed vertical reference for both the sonar and GNSS systems, as opposed to using the water surface and making water surface observations (static drafts), provides improved vertical accuracy as it considers dynamic changes in draft and local water surface variations in the vicinity of the survey. Ellipsoid heights recorded by the POS/MV receiving WAAS corrections provided real-time vertical positioning of multibeam bathymetric data translated to the vessel reference point of the survey platform, which was at or near the waterline. The post-processed motion and navigation data from the POSPAC single base solution was applied to the data, and after editing, a 120-second average of POS/MV GNSS observations were computed to remove wave-induced vertical motion, and a "GPS tide" was computed to correct multibeam soundings to the project vertical datum using a NOAA VDatum conversion.

4.3 Survey Methodology

The *Blake* was mobilized in Gulfport, MS on 7-8 December 2021. Geophysical survey instruments were received, unpacked, loaded aboard the *Blake* and interfaced with data acquisition systems. Vessel calibration checks were conducted and documented prior to getting underway. Immediately after departing, a multibeam patch test was conducted in the Gulfport shipping channel at DEA's standard multibeam patch test area. After completion of the multibeam patch test, the *Blake* began the transit from Gulfport to the survey area offshore Pensacola, FL. For this project, the *Blake*'s complement included 4 vessel crew and 4 survey crew.

Survey operations were conducted 8-10 December 2021. Multibeam data acquisition within the proposed aquaculture sites began immediately upon reaching the survey area. The Teledyne-Reson T50-R multibeam sonar was deployed through the *Blake*'s moonpool using a hydraulic sonar strut. The multibeam survey consisted of overlapping sonar swaths to ensure 100% coverage. Line spacing varied between 40-50m and was adjusted as necessary to meet coverage requirements. T50-R acquisition settings were adjusted as necessary to meet data quality objectives. Multibeam data were logged using Hypack acquisition software and multibeam data coverage was monitored in real time via displays at the multibeam data acquisition station. Multibeam data acquisition was completed the evening of 8 December. Multibeam survey tracklines are shown in Figure 4.

Geophysical data acquisition began the evening of 8 December upon completion of multibeam data acquisition. The EdgeTech 2000-DSS combined side scan sonar/subbottom profiler and tethered Marine Magnetics SeaSpy magnetometer were deployed over the stern using the *Blake*'s hydraulic A-frame and winch. The geophysical survey followed a predesigned line plan consisting of main scheme lines spaced 50m (azimuth 45 degrees) with cross lines spaced 200m (azimuth 135 degrees). The 2000-DSS side scan sonar was operated in simultaneous dual frequency mode with 100kHz imagery acquired with 75m range (150m swath) and 600kHz imagery acquired with 50m range (100m swath); these settings resulted in 150-200% side scan coverage. The 2000-DSS subbottom profiler was operated with a frequency modulated pulse bandwidth of 2-10kHz with a pulse length of 20 milliseconds and a range of 25m. The

SeaSpy magnetometer was operated with a sampling frequency of 4 Hertz (Hz) with a sensitivity of 0.01 nanoTesla (nT; 1nT = 1 Gamma). During geophysical survey operations, the altitude of the towfish above the seafloor was constantly monitored and adjusted as necessary by changing the length of tow cable out. Any changes to the amount of cable out was documented in DEA's LineLog software and recorded by acquisition software for accurate layback positioning. Side scan and subbottom data were recorded using EdgeTech Discover acquisition software and data coverage and quality were monitored in real time via displays at the geophysical data acquisition station. Magnetometer data were recorded using EdgeTech Discover acquisition software with data coverage and quality monitored in real time via a display window in Hypack acquisition software. Geophysical data acquisition was completed the morning of 10 December. Geophysical survey tracklines are shown in Figure 5.

Upon completion of survey operations, the *Blake* began the transit back to Gulfport, arriving the afternoon of 10 December. Demobilization of the *Blake* began 10 December and was completed on 11 December.

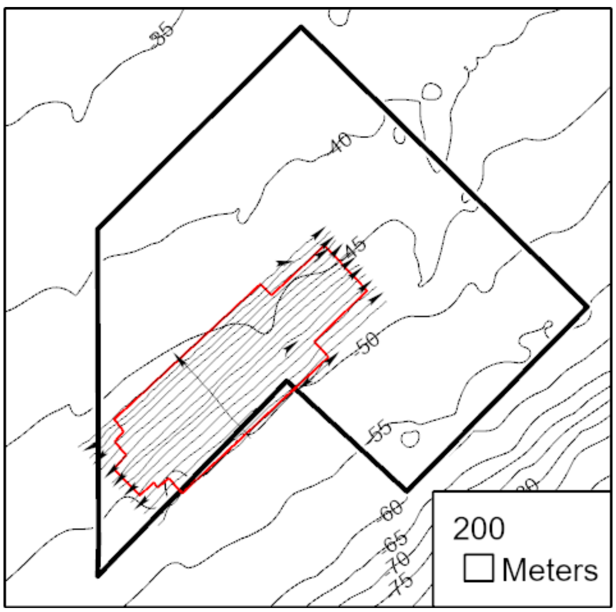

Figure 4 Multibeam survey tracklines. Arrows indicate end of trackline and trackline heading. Boundary of proposed aquaculture sites outlined in red; full project survey area outlined in black. Depth contours are in meters relative to MLLW.

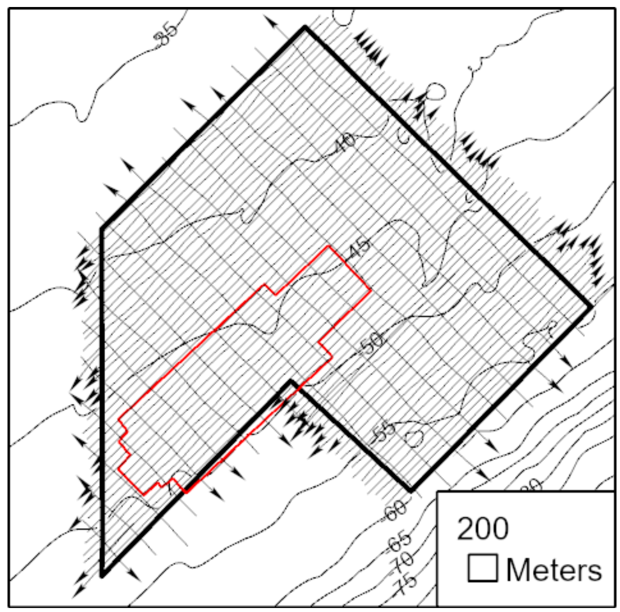

Figure 5 Geophysical survey tracklines. Arrows indicate end of trackline and trackline heading. Boundary of proposed aquaculture sites outlined in red; full project survey area outlined in black. Depth contours are in meters relative to MLLW.

4.4 Quality Control

Acquisition methods followed systematic and standardized workflows established by DEA. The acquisition systems and survey protocols were designed with some redundancy to demonstrate that the required accuracy was being achieved during the survey and provide a backup to the primary systems. Data integrity was monitored throughout the survey through system comparisons.

4.4.1 Position Checks

To confirm the horizontal positional accuracy being received by the Applanix POS/MV and Trimble SPS-855 systems on the *Blake* and to verify system settings, a position check was performed in Gulfport Harbor prior to getting underway. The position check was performed by logging simultaneous position data from each independent GNSS receiver and calculating an observed separation distance between the two measurements. This calculated separation was then compared to the known separation value between the antenna phase centers of each system (determined using precise total station measurements during a prior offset survey for the *Blake*). The position check results for this survey were within 0.03m of the expected separation value.

4.4.2 Multibeam Bar Check Comparison

Prior to departing, a bar check was performed to confirm that the T50-R sonar was functioning properly and that accurate depths were being recorded at the head of the sonar. A plate attached to the end of a wire cable and chain, marked at 2m, was used to bar check the T50-R multibeam sonar. The 2m mark was checked with a measuring tape, and the bar check device was lowered to a 2m-depth below the water surface, a point above the natural bottom where it could be clearly ensonified. The known depth of the bar was compared to the depth of the bar reported by the sonar. Observations were recorded in a comparison log. After processing, the corrected sonar depth accounts for the waterline correction (computed from static draft measurements), roll and pitch correctors, and the calculated vessel offsets. The bar check comparison for this survey displayed a difference between the processed corrected depth and the raw bar depth of 0.028m.

4.4.3 Multibeam Patch Test

A multibeam patch test was performed in Gulfport Ship Channel to measure alignment offsets between the IMU and the T50-P sonar transducer and to determine time delays between the time-tagged sensor data. The patch test consisted of a series of lines run in a specific pattern. A precise timing latency test was performed by running a single line over a flat bottom with induced vessel motion. Roll alignment was determined by evaluating the reciprocal lines run over a flat bottom used for the latency test. The pitch tests consisted of set of reciprocal lines located on a steep slope or over a submerged feature. The yaw error was determined by running parallel lines over the same area as the pitch tests. All lines were run at approximately 3 knots to 6 knots. No changes to system configuration or offsets occurred during this project.

4.4.4 Static Draft Measurements

The static draft of the *Blake* was recorded for a quality assessment of the water line height. Draft measurements were taken from sight tubes located in the port and starboard bilge compartments of the *Blake*. Static draft readings were recorded before and after the survey to ensure the best approximation of the true draft at the vessel reference point due to loading changes from fuel consumption and variation in ballast distribution. While static draft changes were not necessary for bathymetric data processing (instead, a GPS tide was computed and reduced to project datum through a NOAA VDatum adjustment), they were incorporated to ensure an accurate waterline correction for the multibeam bar check comparison.

4.4.5 Sound Velocity Corrections

During data acquisition, the MVP acquired numerous sound velocity profiles through the water column to properly correct the multibeam data for acoustic refraction during data processing. Casts were taken at approximately 20-minute intervals over a wide area to ensure both spatial and temporal changes in the sound speed profile were captured throughout the survey. Profiles typically extended to at least 95% of water depth. Sound speed measurements from the MVP were routinely compared against those from the AML MicroSV sensor on the T50-R sonar head to verify instrument performance and monitor real-time changes in surface sound speed that might indicate the need for an additional cast. All DEA sound speed sensors are calibrated annually to ensure accuracy.

4.4.7 Real-Time Monitoring Procedures

During multibeam data acquisition, the sonar operators monitored the multibeam sonar systems, tracked vessel navigation and motion systems, recorded sound velocity measurements, and maintained the digital line log. The multibeam sonar system status was displayed in the Reson SeaBat user interface. Adjustments to range, power, and gain were made as necessary to optimize data quality and coverage and all changes were noted in the digital line log. Primary and secondary navigation systems were monitored to verify quality position data were acquired at all times; raw attitude and nadir depth were also recorded in Hypack RAW format as a supplementary backup. Typical windows for monitoring raw sensor information included timing synchronization, vessel motion, number of satellites, horizontal dilution of precision (HDOP), and position dilution of precision (PDOP; amount of error). Vessel motion and position accuracy was monitored using Applanix POSView software. The Reson SeaBat, Hypack, and POSView user interfaces were displayed on two monitors mounted at the acquisition station. The sonar operator also worked closely with the vessel operator to monitor and adjust vessel speed and course to meet coverage requirements and sounding density.

During geophysical data acquisition, geophysicists monitored and adjusted the 2000-DSS and tethered magnetometer systems as required, including towfish height and attitude, and observed the digital displays for image quality. Changes to sensor settings, offset configurations, data quality, and features were recorded in the digital line log. Typical windows for monitoring raw sensor information included scrolling displays for side scan sonar imagery and subbottom profile imagery in EdgeTech Discover software and a scrolling display for magnetic field data in Hypack software. In addition, windows showing the amount of tow cable out, towfish attitude, towfish depth, and sonar signal voltage were displayed at the geophysical acquisition station. Geophysicists maintained the digital line log and worked closely with the vessel operator to adjust vessel speed and maintain course along the planned track lines.

5.0 Data Processing

All raw survey data were hand carried to DEA's Vancouver, WA headquarters, where the data were inventoried and prepared for processing. All raw data, processed data, derivative products, and interim deliverables were routinely backed up during the execution of this project.

5.1 Bathymetric Data Processing

After initial data assessments were complete, the raw multibeam data were prepared for import into CARIS Hydrographic Information Processing System (HIPS) software, which was used for all bathymetric data processing tasks. Upon import into CARIS HIPS software, the raw multibeam data were converted from Hypack HSX file format into CARIS HDCS format.

Multibeam patch test data were analyzed and alignment corrections were calculated and applied during processing. Trimble Applanix POS/MV TrueHeave® was applied to provide a more robust filtered solution for wave-induced vertical motion, and a GPS tide was computed and applied to the data, generated from smoothed POS/MV height measurements of the vessel reference point in order to correct for wave-induced vertical motion and subsequently reduce soundings to MLLW elevations. Sound speed profiles were incorporated to correct multibeam slant range measurements and compensate for refraction in the water column. Sound speed profiles were imported into CARIS HIPS and applied to soundings using the "nearest in distance within time" function.

Applanix POSPac software was used to calculate Smoothed Best Estimate of Trajectory (SBET) files. The SBET files were calculated using corrections transmitted by the Alabama Department of Transportation's Continuously Operating Reference Station (CORS) site "ALDI" located on Dauphin Island, AL. The final SBET files combined the vessel attitude and position data to produce a corrected horizontal and vertical position solution. Soundings were converted from ellipsoid heights (NAD83) to the project vertical datum (MLLW) in CARIS HIPS using the computed GPS tide and a 100m gridded separation model generated from NOAA's online VDatum tool (version 4.1.2).

After position, motion, and sound velocity corrections were applied, the multibeam swath data were filtered to 90 degrees (45 degrees per side) and remaining soundings were gridded for review and editing. Review of bathymetric data was conducted primarily using the CARIS subset editor, where lines were reviewed together for line-to-line comparison and edited to remove erroneous soundings. Various bathymetric surface child layers (e.g. standard deviation) and additional editing/quality control tools within CARIS HIPS were useful to assess for potential systematic biases, timing errors, or alignment offsets, and to identify bathymetric features.

After the completion of bathymetric data processing, review, and analysis, soundings were gridded using a standard swath angle surface algorithm in CARIS at a resolution of 1m. The bathymetric surface was exported in Geotiff format. Bathymetry products are referenced to NAD83 UTM Zone 16 North with horizontal units in meters and vertical elevation in meters relative to MLLW.

5.2 Side Scan Data Processing

Side scan data were processed using Chesapeake SonarWiz software. Side scan data were bottom tracked and then processed using an empirical gain normalization (EGN) table to enhance seafloor definition. Side scan data were reviewed line by line and targets were marked on acoustic contacts of interest for geological and archaeological review. Contact images, positions, and measurements were exported to a report. A final side scan sonar mosaic was generated using the high frequency (600kHz) side scan imagery using a least square blending technique and exported in Geotiff format at a 50cm pixel resolution.

5.3 Subbottom Profiler Data Processing

Subbottom profiler data were processed using Chesapeake SonarWiz software. Subbottom profiles were bottom tracked and Automatic Gain Control (AGC) was applied to adjust the brightness and contrast of subseafloor reflectors. A blank water column function was also applied to eliminate any features within the water column. Subbottom profiles were reviewed line by line and targets were marked on acoustic contacts of interest for geological and archaeological review. Contact images and positions were exported to a report. Subbottom profiles were exported as high-resolution images with annotations at 152m (500 foot (ft)) intervals as required by project specifications. To aid the end user(s) in reviewing subbottom profiles, corresponding navigation lines with shot points at the same interval were exported in shapefile format.

5.4 Magnetometer Data Processing

Magnetometer data were processed using Hypack's MagEditor software module. Daily one-minute observations from the magnetometer base station at Stennis Space Center, MS were downloaded from the International Real-Time Magnetic Observatories Network (INTERMAGNET) and applied to the raw magnetometer data to correct for diurnal variations in regional magnetic field strength. After diurnal corrections were applied, the magnetometer data were reviewed line by line and targets exceeding >1nT were marked for archaeological review. Target information including position, peak-to-peak anomaly amplitude, and duration were exported to a report. The processed magnetometer data and targets were exported to ArcGIS software, in which contours were generated to illustrate the magnetic field and anomalies within the survey area.

6.0 Data Interpretation

6.1 Geological and Geophysical Review and Interpretation

The processed multibeam bathymetry, side scan sonar imagery, subbottom profiles, magnetometer data and all acoustic contacts and magnetic anomalies were reviewed by DEA geologists to infer surficial substrate types and subsurface stratigraphy and to assess the survey area for potential geohazards. It is important to note that these surficial interpretations are inferences based solely on acoustic properties. Results are shown in Maps 1-5 (1:12,000 scale) and tabulated in Appendices A-C. Images of all acoustic contacts and magnetic anomalies are included with the digital deliverables.

Side scan sonar imagery and multibeam bathymetry were digitally reviewed to infer surficial geology. The processed side scan sonar mosaic (Map 3) shows a relatively uniform acoustic reflectivity over most of the survey area which suggests a homogenous surficial substrate with minimal relief. The predominant surficial substrate is interpreted to be sand based on the bottom morphology, which consists of ripples of various wavelengths and orientations, and the rapid attenuation of acoustic energy below the seafloor, which is commonly associated with sandy substrates. Multibeam bathymetry only covers the proposed aquaculture sites but appears to confirm a relatively flat and predominantly sandy substrate. The exception is a linear zone of higher acoustic reflectivity at the southeastern boundary of the survey area which appears to be rock or other hard, consolidated substrate. This linear feature is 40-50m in width, approximately 4m in height, extends approximately 1,800m along the eastern boundary of the survey area, and appears to continue northward and southward outside of the survey area. The linear feature appears to be composed of exposed hard bottom areas that could support biological communities. To what extent or types of biological communities may be present in this area cannot be discerned from the current dataset. 22 side scan sonar contacts identified during data processing and review were evaluated for geologic context (Maps 2-3 and Appendix A). The side scan sonar contacts consisted of small-scale depressions (<10m diameter) and objects (<10m length) with corresponding localized scour features. None of the features represent a significant geohazard.

Subbottom profiles were digitally reviewed to infer subseafloor geology. The side scan sonar mosaic and multibeam bathymetry were tied to the subbottom profiles in order to correlate seafloor features with subseafloor features. Subbottom profiles generally showed approximately 3-5m of subseafloor depth penetration due to thick subseafloor sand layers which impeded acoustic penetration; however, several infilled depressions with accumulated sediment thicknesses of up to 10m demonstrated that the subbottom profiler instrument obtained the required acoustic penetration. Geologic interpretation consisted of identifying and highlighted the bottom of the unconsolidated sediment layer which was often associated with the layer impeding further penetration of the acoustic signal. Subbottom profiles were manually reviewed and interpreted line by line to digitize and calculate the thickness of the unconsolidated sediment layer. The digitized data points were gridded to produce an isopach map depicting the thickness of the unconsolidated sediment layer (Map 5). The isopach map indicates that the unconsolidated sediment layer is generally a minimum of >3-5m thick except for several depressions in which unconsolidated sediments have accumulated to a thickness of up to 10m. These infilled depressions are interpreted to be paleochannels or other remnant features from lower sea level stand(s). The unconsolidated sediments in these features do not display any significant acoustic contrast with the surrounding sediments, suggesting that the features are filled with the same or similar sandy substrate as found on the seafloor. One acoustic contact was identified during subbottom data interpretation (Appendix B). The contact is buried within an infilled depression at a subseafloor depth of approximately 3m. The contact displays a prominent parabolic reflector indicating a relatively hard feature. The feature was only detected on one survey line, suggesting that the feature is relatively small and not continuous. The feature is not associated with any side scan sonar contacts or magnetic anomalies detected during this survey. This feature does not appear to represent a significant geohazard. No shallow gas was noted in subbottom profiles.

Magnetic field and magnetic anomalies were reviewed along with side scan sonar imagery, multibeam bathymetry, subbottom profiles, and all acoustic contacts in order to potentially correlate features. 41 magnetic anomalies identified during data processing were evaluated for geologic context (Map 2, Map 4 and Appendix C). Nine magnetic anomalies displayed dipolar signatures, 30 anomalies displayed monopolar signatures, and two anomalies displayed signatures with multiple components. Of the 41 magnetic anomalies, only three anomalies had a peak-to-peak magnitude greater than 10nT. 10 magnetic anomalies were associated with side scan sonar contacts, however a review of the side scan contact images showed that these objects were small (<10m) depressions or objects with corresponding localized scour zones. None of the detected magnetic anomalies appear to represent a significant geohazard.

6.2 Cultural Resources Review and Interpretation

An assessment for the presence of potentially significant precontact and maritime cultural resources within the survey area was conducted separately by RECON archaeologists and relied on multiple lines of evidence. These lines of evidence included an assessment of the natural environment, a review of relevant cultural histories, and a review of the processed multibeam bathymetry, side scan sonar imagery, subbottom profiles, magnetometer data and all acoustic and magnetic contacts for signatures consistent with the presence of such cultural resources.

6.2.1 Review of Natural Environment

The survey area is located approximately 30km offshore Pensacola Bay, lying in open waters that range in depth from 42m to 53m MLLW. Onshore geology is dominated by surface expressions of Quaternary deltaic deposits associated with the fluvial systems that enter Pensacola Bay. These fluvial systems have deposited siliciclastic materials over the carbonate formations that form the majority of bedrock in Florida. The Floridan aquifer is confined in this area, and the spring systems characteristic of the Florida coast to the east much less common. Instead, this portion of the Gulf of Mexico coastline is fed by a surficial aquifer, with freshwater inputs from the Escambia and Yellow Rivers that enter the bay system in the Pensacola region from the north (Newton 2018).

The most recent relative sea level (RSL) curve relevant to the survey area was generated by Joy (2019). This RSL curve demonstrates that the survey area was a coastal environment by 11,000 years before present (BP). This constrains potential human occupation of the survey area to before this time. By 11,000 years BP, submergence was underway and the survey area transitioned from a coastal to a marine environment.

6.2.2 Review of Cultural and Maritime History

Given the location and setting of the survey area, the only human groups that could have occupied the area were Paleoindian. The Paleoindian period is generally subdivided into early, middle, and late cultural phases, with each phase displaying changes in tool types and technology. The early Paleoindian phase represents the first human colonization of the region and the emergence of a toolkit adapted to Bølling-Allerød warm period (14,690 - 12,890 years BP) conditions, while the middle Paleoindian phase demonstrates refinement of this toolkit that likely echoes human mastery of their environment. The late Paleoindian phase is characterized by regionalization of toolkits likely developed in response to more heterogenous ecological conditions that also included the extinction of the last megafauna and the Younger Dryas cooling episode (12,900 - 11,700 years BP). Table 1 gives general age ranges and cultural characteristics approximated following various North American and regional studies (e.g. Davis et al. 2019; Dunbar 2016; Halligan et al. 2016; Smallwood et al. 2015).

Table 1 Cultural phases of the Paleoindian period, their timing, and characteristics

Cultural Phase	Approximate Timing	Cultural Characteristics
Early Paleoindian (Pre-Clovis)	>15,000 - ~13,500 years BP	Initial colonization; unfluted lanceolate points
Middle Paleoindian (Clovis)	~13,500 - ~12,500 years BP	Adaptation to conditions; fluted lanceolate Clovis points
Late Paleoindian	~12,500 - ~ 11,500 years BP	Response to YD conditions; unfluted lanceolate points showing regionalization of form

Paleoindian occupations in Florida include some of the oldest known sites in North America. To the east of the survey area along the Big Bend, where the Florida peninsula meets the panhandle, multiple sites have been documented within sediment deposits preserved in the sinkhole features that dot this karstic portion of the Florida landscape (Webb 2006). Paleoindian sites are most common where the karstic landscape of Florida is only shallowly buried and may not represent a good analog to sites closer to the survey area, where that carbonate bedrock is buried.

Archaeological evidence from time periods this far in the past is usually scant and offers insights only into the more fundamental types of cultural practices such as degree of group mobility, diet, and technology; the consequence is that most Paleoindian sites yield only stone tools. However, thanks to excellent preservation in sinkhole deposits in Florida within a few hundred kilometers of the survey area, substantially more evidence has been recovered for cultural practices beyond just these lithic items. The materials suggest that groups were probably small, mobility may have been varied, and that diet may have included diverse foods beyond simple big game hunting.

The raw materials from which tools were made offer additional hints concerning mobility. Initial studies assumed that Paleoindian groups were highly mobile hunters who rapidly colonized the landscape as the last ice sheets retreated, prioritizing deposits of high-quality tool stone, for which they were willing to travel significant distances (Surovell 2000). This appears to be true for some regions, such as the northeastern United States (Lothrop et al. 2016; Lothrop et al. 2018). However, Paleoindian sites east of the survey area tend to render stone tool artifacts mostly made from local to regional high-quality chert, which appears abundantly as nodules and outcrops within the carbonate bedrock that correlates to the unconfined portion of the Floridan Aquifer across the state (Upchurch 1982). West of the survey area, the enigmatic offshore site of McFadden Beach along the Texas coast has yielded numerous stone tool artifacts made from materials that might have come from as far afield as the northern Plains (Stright 1999).

An assessment of nearby contemporary sites is a reasonable way to model for what human occupation might have looked like in the survey area. A selection of onshore sites within 100km of the survey area was examined for foundational environmental conditions selected due to their association with Paleoindian occupations across the southeastern United States. These foundational environmental conditions include proximity to major fluvial systems, natural springs (a strong correlation in Floridian sites east of the survey area), and geologic formations known to yield high quality raw materials for stone tool manufacture (Dunbar 2016; Miller 2016; Thulman 2009). Paleoindian period sites in the broader context of Florida are often found where carbonate bedrock is only shallowly buried, making both high quality tool stone and water contained within the aquifer associated with that bedrock readily available. If known sites near the survey area were more like those found further to the east, then they should correlate to both high quality geological resources (chert-yielding carbonate formations) and natural springs. Conversely, if they more closely resemble Paleoindian settlement patterns elsewhere in the southeast, they should show correlations to high quality geological resources and major fluvial systems. Unfortunately, coastal Paleoindian sites for the Gulf of Mexico and Atlantic seaboard are poorly understood and are unlikely to mirror known terrestrial sites that would have been inland and upland at the time they were occupied (Joy 2020). Coastally adapted foraging populations tended to rely on different approaches to subsistence than inland ones, leading to differences in toolkits and site types. Mobility may have been lower, characterized by low impact, shorter range, and shorter-term habitation along a given stretch of coastline, and included toolkits less focused on multi-purpose, informal, and more utilitarian forms (Andrefsky 1994, 2009; Bird and Bliege Bird 2000; Bird et al. 2002; Bird et al. 2019; Erlandson et al. 2020, Joy 2020). In addition, natural springs are more common along coastlines during periods of lowered relative sea level (Faure et al. 2002), suggesting that coastal zones might have been especially attractive to early Paleoindian occupants. Current data do not fully resolve this question.
To summarize, there is the potential for precontact Paleoindian period sites to be associated with either relict fluvial features or natural springs in the survey area. These sites are most likely to be middle to late

Paleoindian period occupations, although early, potentially coastally adapted Paleoindian sites are also possible.

Post- contact cultural resources in the survey area are most likely to consist of evidence left behind by maritime activities associated with the port of Pensacola Bay just to the north, which has a rich maritime history dating from before the first landing by Tristan De Luna in 1559. Methods for assessing the potential for historic maritime cultural resources within the survey area included a review of archival records and extant site datasets. Regional and local archaeological studies confirm the maritime culture of the region. More than 40 wrecks had been recorded in the Pensacola Bay area by 1999 (Smith in Bense ed. 1999). A more focused review of Florida Master Site File databases for the purposes of this study shows that one wreck, the "Brass Wreck" (8ES02994) lies 13.5km north of the survey area. However, there are no records of shipwrecks, or 20th century and younger aircraft loss sites, within the survey area or a one-mile buffer.

6.2.3 Evaluation of survey area

The presence of potential precontact sites within a given area of the continental shelf is not only controlled by former human occupation, but also by the potential for such sites to become preserved in the archaeological and sedimentological record. Marine transgression is erosive by its very nature; as the relative sea level rises, inland areas are subjected to wave energies, coastal storms, and tidal forces (Swift 1968; Swift et al. 1971). For a submerged precontact site significant enough to require assessment and archaeological mitigation to survive, it must be buried sufficiently to remain relatively unimpacted by such forces. This requires that the site lie within a depositional environment prior to submergence. Examples of these in the region include karstic sinkholes and floodplains proximal to fluvial terraces. Both such landforms were also clearly favored by Paleoindian populations, and therefore such landforms are considered "high probability" landforms based on both cultural histories and geomorphological serendipity. Therefore, assessment of the survey area for potentially preserved precontact sites focuses here on review of hydrographic and geophysical survey data gathered to assess both seabed and below-seabed conditions for remnants of such landforms. Federal and State guidelines require line by line review of side scan sonar, multibeam bathymetry, magnetometer data, and sub-bottom profiler data.

Side scan sonar

Seafloor conditions as indicated by side scan sonar imagery are predominantly sandy with minimal relief; one rocky outcrop appears in the southeastern portion of the survey area, running NE to SW, with a maximum width along its shorter axis of approximately 45-50m and a maximum length along its longer axis of approximately 900m. 22 acoustic contacts were recorded during the geophysical survey (Appendix A). Examination of their morphology based on the data as ensonified during survey indicates that they are largely composed of small depressions, geological formations, and small objects that include proximal scour nuclei. These contacts are generally between 5 and 10m across and do not appear in a pattern suggestive of anthropogenic activities typically associated with precontact submerged archaeological sites.

Multibeam bathymetry

The multibeam survey did not encompass the entire survey area but the available bathymetry confirms the generally sandy nature of seabed conditions that show minimal relief. No bathymetric features were apparent that are consistent with precontact submerged archaeological sites at the seabed.

Subbottom Profiles

Subbottom profiles shows adequate depth penetration to approximately 10m. This allowed for sufficient line by line review for the presence of preserved landforms also consistent with Paleoindian cultural practices. Line by line review of the subbottom data indicate that two potential channel systems exist in the survey area; one that is very shallow and within 2m of the surface, and another that is deeper, below the Holocene transgressive ravinement surface. Channel fill in both systems appears nearly acoustically transparent in subbottom profiles, suggesting that they are infilled by materials similar to the sandy, reworked sediments in the vicinity. One subseafloor contact was also identified within a channel itself and appears to represent a geological feature; its location within an infilled channel argues against anthropogenic associations. No clear examples of potential natural springs or geological outcrops consistent with the type of geological resources favored by Paleoindian groups were apparent in subbottom profiler data.

Magnetometer
Review of magnetometer data included 41 anomalies (Appendix C). 9 anomalies were dipolar and 32 anomalies were monopolar. Intensities ranged from 0.85nT to 23.29nT. Duration (distance over ground) ranged from 44.92 to 265.31m. Eight magnetic anomalies were associated with 11 side scan sonar contacts. Total magnetic field contours revealed one locus that approximately 70m across that is associated with three magnetic anomalies: (Anomaly ID 37, 38 39). This locus is also associated with two side scan contacts (345-021943P and345-025650S). Total magnetic field contours revealed another locus that is 60m across that is monopolar but is not associated with a side scan contact. Review of the magnetic anomalies, including any associated side scan contacts, did not reveal any patterns suggestive of anthropogenic activities typically associated with precontact submerged archaeological sites.

Given the RSL curve for the area, it is most likely that the older, deeper channel system represents paleochannels dating to the last sea level low stand, at the Last Glacial Maximum (LGM; approximately 18,000 years BP), when fluvial systems incised the exposed continental shelf. These channels gradually transitioned to aggradational meandering forms as sea level rose at the termination of the LGM across the southeastern U.S. (Leigh 2008). As the coastline approached the survey area around 11,000 years BP, the older channel system appears to have been eroded, with no evidence for preserved proximal fluvial terraces, and then buried by the reworked Holocene marine sediments present above them.

The younger, shallower channel system likely represents the final stages before marine transgression drowned and buried this location and may be remnants of tidal creeks draining the coastline zone. As with the older, deeper channel system, these channels show no evidence for preserved proximal features such as fluvial terraces. While this younger system represents a younger episode of channel downcutting, it does not always directly correlate to the older channel system which appears to have been eroded and buried before these smaller, shallower, younger channels developed. This in turn suggests significant geomorphological evolution occurred within the survey area between the time that the older channel system was active and the development of the younger, smaller channel system. Evidence for what specific changes this former coastal plain experienced are not evident in subbottom profiles, however, further supporting an interpretation that this location has experienced significant erosion. Given the degree of erosion and burial within the survey area, it is unlikely that precontact Paleoindian period sites remain *in situ* and identifiable at this time.

7.0 Conclusions

DEA conducted a hydrographic and geophysical survey of a proposed offshore aquaculture site and clearance buffer located approximately 30km offshore Pensacola, FL. Data postprocessing yielded multibeam bathymetry (proposed aquaculture sites only), a side scan sonar mosaic and seafloor acoustic contacts, subbottom profiles and subseafloor acoustic contacts, and diurnally corrected magnetic field data and magnetic anomalies. Subbottom profiler data were also digitally analyzed to produce an unconsolidated sediment thickness isopach map.

DEA examined the hydrographic and geophysical data products and acoustic and magnetic anomalies to infer seafloor and subseafloor geology. Multibeam bathymetry and side scan sonar imagery indicate a unconsolidated sandy substrate devoid of vegetation and with minimal bathymetric relief. Subbottom profiles indicate that the unconsolidated sediment layer is generally a minimum of >3-5m thick except for infilled paleochannels and other remnant features from lower sea level stand(s) in which unconsolidated sediments have accumulated to a thickness of up to 10m. A linear ridge with approximately 4m of bathymetric relief extends along the southeastern boundary of the survey area. In contrast to the rest of the survey area, the ridge is characterized by higher acoustic reflectivity which is suggestive of rock or other hard, consolidated substrate that could support biological communities; to what extent or types of biological communities may be present in this area cannot be discerned from the current dataset. 22 side scan sonar contacts were identified and reviewed; these features consisted of small-scale depressions (<10m diameter) and debris objects (<10m length). 41 magnetic anomalies were identified and reviewed, however only three magnetic anomalies had a significant magnitude (>10nT). 10 of the magnetic anomalies were coincident with small depressions or debris objects observed in side scan sonar imagery. None of the acoustic contacts or magnetic anomalies represent a geohazard.

An archaeological review and assessment was conducted separately by RECON. There are no records of shipwrecks or downed aircraft within the survey area and a 1-mile buffer. Multibeam bathymetry and side scan sonar imagery do not indicate any features suggestive of submerged archaeological sites and a review of the acoustic contacts and magnetic anomalies did not reveal any patterns suggestive of anthropogenic activities.

<u>Unanticipated Discoveries</u>
The possibility always exists for unexpected, undetected archaeological materials to be encountered during development activities on and below the seabed, and an unanticipated discoveries plan to include mitigation strategies should always be included in construction plans (Appendix D).

8.0 Project Deliverables

The following deliverables will be provided in digital format:

- Multibeam bathymetry (proposed aquaculture sites only) in Geotiff format
- Side scan sonar image mosaic in Geotiff format
- Side scan sonar acoustic contacts in ESRI shapefile format
- Side scan sonar acoustic contact images in JPEG format
- Subbottom profiles in JPEG format (all profiles annotated at 152m / 500ft interval)
- Subbottom profiler acoustic contacts in ESRI shapefile format
- Subbottom profiler acoustic contact images in JPEG format
- Unconsolidated sediment thickness isopach map in ESRI shapefile format
- Total magnetic field contours in ESRI shapefile format
- Magnetic field anomalies in ESRI shapefile format
- Magnetic field anomaly images in JPEG format
- As-run survey tracklines for hydrographic survey in ESRI shapefile format
- As-run survey tracklines for geophysical survey in ESRI shapefile format
- As-run geophysical survey trackline shot points (152m / 500ft interval) in ESRI shapefile format

All deliverables are referenced to NAD83 UTM Zone 16 North with horizontal units in meters. Bathymetric depths are referenced to MLLW with vertical units in meters.

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Appendix A: Side Scan Sonar Contacts

Contact Name	X[1]	Y[1]	Line Number	Range (m)	Length (m)	Width (m)	Height (m)	Magnetic Anomaly Association(s)
345-002156P	503563	3329059	1	42.98	5	2	1.33	-
345-021943P	501339	3330629	53	32.94	5	5	0.3	37,38,39
345-031518S	500776	3329763	49	25.02	5	3	2.66	40
345-025650S	501339	3330629	54	13.42	5	5	0.39	37,38,39
345-035522P	500767	3329762	50	14.52	5	3	2.46	40
344-060617P	500798	3329020	39	16.27	5	3	1.65	4
344-074309S	500807	3329023	38	26.64	8	5	0.63	4
344-085024S	500826	3329245	42	35.55	5	5	0.59	7
344-094000P	500827	3329241	41	19.34	5	4	0.58	7
344-114846P	501611	3329017	28	38.74	5	3	0	13
344-140907S	499931	3327557	31	36.98	5	5	0	-
344-164719P	503117	3329374	11	11.13	8	2	2.1	-
344-174306P	502018	3328145	10	48.52	5	2	0.13	20
344-183118S	502023	3328146	9	6.06	4	3	0.71	20
344-191455P	502492	3328491	8	37.16	5	5	2.08	22
344-200002S	502492	3328490	7	14.39	8	3	1.92	22
344-204416P	502490	3328354	6	32.2	3	3	1.04	25
344-213114S	502501	3328355	5	15.63	3	2	1.12	25
344-230030P	502307	3328800	14	12.98	8	2	0.57	-
344-101844S	499920	3327551	30	12.93	4	4	0	-
344-124418S	501611	3329016	27	5.18	3	3	0	13
344-222832S	502308	3328800	15	33.63	5	3	0.69	-

[1]NAD83 UTM Zone 16N in meters

Note: Contact images are included with digital deliverables

Appendix B: Subbottom Profiler Contacts

Contact Name	X[1]	Y[1]	Line Number	Range (m)	Deptht (m)	Magnetic Anomaly Association(s)
344-131907SBP	501605	3329354	32	9.15	3.0	-

[1]NAD83 UTM Zone 16N in meters

Note: Contact images are included with digital deliverables

Appendix C: Magnetic Anomalies

Anomaly ID	X[1]	Y[1]	Line Number	Tow Height (m)	Signature Type	Magnitude (nT)	Duration (m)
0	500139	3328372	39	5	Dipolar	1.24	66.37
1	501142	3329447	40	5	Monopolar	2.75	265.31
2	500459	3328772	40	5	Monopolar	1.58	141.12
3	500914	3329513	44	5	Monopolar	11.29	183.65
4	500852	3329027	38	5	Monopolar	2.6	65.41
5	500884	3329347	42	5	Monopolar	2.55	77.29
6	501285	3329741	42	5	Monopolar	1.99	128.29
7	500848	3329234	41	5	Dipolar	1.25	89.6
8	501153	3329539	41	5	Monopolar	2.08	182.64
9	501454	3329411	35	5	Monopolar	2.15	104.33
10	501635	3329519	34	5	Monopolar	1.96	99.39
11	501504	3329324	33	5	Monopolar	1.66	119.49
12	501630	3329456	33	5	Dipolar	1.34	135.27
13	501608	3329006	27	5	Dipolar	5.22	116.4
14	500161	3327558	27	5	Monopolar	2.02	173.35
15	501490	3329234	32	5	Monopolar	3.13	95.59
16	501546	3329293	32	5	Monopolar	1.8	93.56
17	501694	3329011	26	5	Monopolar	2.09	103.44
18	502688	3329018	12	5	Monopolar	1.48	55.43
19	501995	3328192	10	5	Monopolar	1.28	57.9
20	502021	3328136	9	5	Dipolar	20.16	101.62
21	502763	3328755	7	5	Monopolar	6.44	83.99
22	502498	3328476	7	5	Dipolar	3.17	99.55
23	501930	3327908	7	5	Monopolar	1.33	83.56
24	502356	3328266	6	5	Monopolar	5.05	117.68
25	502500	3328333	5	5	Monopolar	8.38	135.96
26	501805	3328448	16	5	Monopolar	1.47	79.65
27	502199	3327960	4	5	Monopolar	0.85	67.2
28	502192	3327884	3	5	Monopolar	1.97	94.23
29	502228	3328703	14	5	Monopolar	2.98	84.87
30	503356	3328996	2	5	Monopolar	3.7	70.17
31	503289	3328943	2	5	Dipolar	3.83	73.29
32	502225	3327857	2	5	Dipolar	5.57	180.72
33	502282	3327834	1	5	Monopolar	1.12	70.64
34	501367	3328106	18	5	Dipolar	1.25	44.92
35	501570	3330313	46	5	Monopolar	1.26	54.68
36	500087	3328830	46	5	Monopolar	2.46	87.65
37	501392	3330639	53	5	Multiple Components	2.2	181.89
38	501349	3330658	54	5	Multiple Components	23.29	194.01
39	501282	3330658	55	5	Monopolar	5.32	82.2
40	500749	3329762	50	5	Monopolar	2.64	174.41

[1]NAD83 UTM Zone 16N in meters

Note: Images of magnetic anomalies are included with digital deliverables

Appendix D

UNANTICIPATED DISCOVERIES OF ARCHAEOLOGICAL SITES, HISTORIC SITES, and SUBMERGED CULTURAL RESOURCES INCLUDING HUMAN REMAINS

Although a project area may receive a complete cultural resource assessment survey, it is impossible to ensure that all cultural resources will be discovered. Even at sites that have been previously identified and assessed, there is a potential for the discovery of previously unidentified archaeological components, features, or human remains that may require investigation and assessment. Therefore, a procedure has been developed for the treatment of any unexpected discoveries that may occur during site development.

If unexpected cultural resources are discovered, the following steps should be taken:

1) Initially, all work in the immediate area of the discovery should cease and reasonable efforts should be made to avoid or minimize impacts to the cultural resources.
2) The lead agency should be contacted immediately and should evaluate the nature of the discovery.
3) The agency should then contact the State Historic Preservation Officer (SHPO) and if necessary, the State Archaeologist.
4) As much information as possible concerning the cultural resource, such as resource type, location, and size, as well as any information on its significance, should be provided to the SHPO.
5) Consultation with the SHPO should occur in order to obtain technical advice and guidance for the evaluation of the discovered cultural resource.
6) If necessary, a mitigation plan should be prepared for the discovered cultural resource. This plan should be sent to the SHPO for review and comment. The SHPO should be expected to respond with preliminary comments within two working days, with final comments to follow as quickly as possible.
7) If a formal data recovery mitigation plan is required, development activities in the near vicinity of the cultural resource should be avoided to ensure that no adverse impact to the resource occurs until the mitigation plan can be executed.

In the event that unrecorded shipwreck sites and/or other underwater archaeological resources are discovered (adapted from The Commonwealth of Massachusetts, Board of Underwater Archaeological Resources, Office of Coastal Zone Management):

1) In the event that a suspected shipwreck or other site is uncovered during construction activity, that activity shall immediately be halted in the area of the find until it can be determined whether the object is a shipwreck or other underwater archaeological resource and if it represents a potentially significant feature or site.
2) The project field staff will immediately notify the lead agency upon the suspension of work activities in the area of the find. Notification will include the specific location in which the potential feature or site is located.
3) The agency will immediately contact its cultural resource management consultant to review the information. On-site personnel will provide information on the location and any discernible characteristics of the potential cultural resource (the target), and any survey data depicting the find. This information will be forwarded for review by the agency for the cultural resource management consultant.
4) If the project archaeologist determines that the site, feature, or target is not potentially cultural, the project field staff through the agency will be notified by the project archaeologist that work may resume. The project archaeologist will also notify the agency of this determination.
5) If, based upon both previously acquired and current remote sensing survey data, or other indications (e.g., timbers, etc.), it is determined that the new target is possibly a shipwreck or other potential submerged cultural resource, the project archaeologist will inform the agency, who will inform the project

field staff that work may not resume at the given location until notified in writing by the agency. The cognizant review agencies, SHPO (State Historic Preservation Officer), and Advisory Council (if applicable) will be notified of this determination within 2 working days.
6) A visual inspection by archaeological divers or remotely operated vehicle (ROV) will be conducted to determine if the site is potentially eligible for listing in the National Register. The results of the survey will be formally submitted to cognizant review agencies, SHPO, and the Advisory Council (if applicable) for final review and comment. The SHPO and the agency will endeavor to respond within 2 working days of receiving the inspection results and recommendations.
7a) If it is determined that the target, feature, or site does not represent a potentially significant resource, and the agency is in receipt of written comment from the review agency(s), work may resume in that area.
7b) If a National Register determination cannot be made in accordance with Step 6, the agency may either undertake additional research to satisfy Step 6 or exercise Step 8 (avoidance).
8) If agency review concurs or concludes that the site may be important and is potentially National Register eligible, the agency will develop avoidance measures to eliminate the site from the Area of Potential Effects. Any proposed avoidance measures will be made available to the cognizant review agencies for review and comment.
9) If avoidance measures cannot be developed and executed, the resource may be excavated and/or removed only under a memorandum of agreement with all interested parties including the State Archaeologist, SHPO, agency, and, if applicable, the Advisory Council subject to appropriate state permits. This memorandum will outline an adequate data recovery plan that specifies a qualified research team and an appropriate research design. The appropriate permits must also be secured from the Florida Bureau of Archaeological Research prior to conducting any further disturbance to the site.

If HUMAN REMAINS are encountered on a site during development, the stipulations of Chapter 872.05 (Offenses Concerning Dead Bodies and Graves) should be followed.

All work in the near vicinity of the human remains should cease and reasonable efforts should be made to avoid and protect the remains from additional impact. A qualified Professional Archaeologist should be retained to investigate the reported discovery, inventory the remains and any associated artifacts, and assist in coordinating with state and local officials.

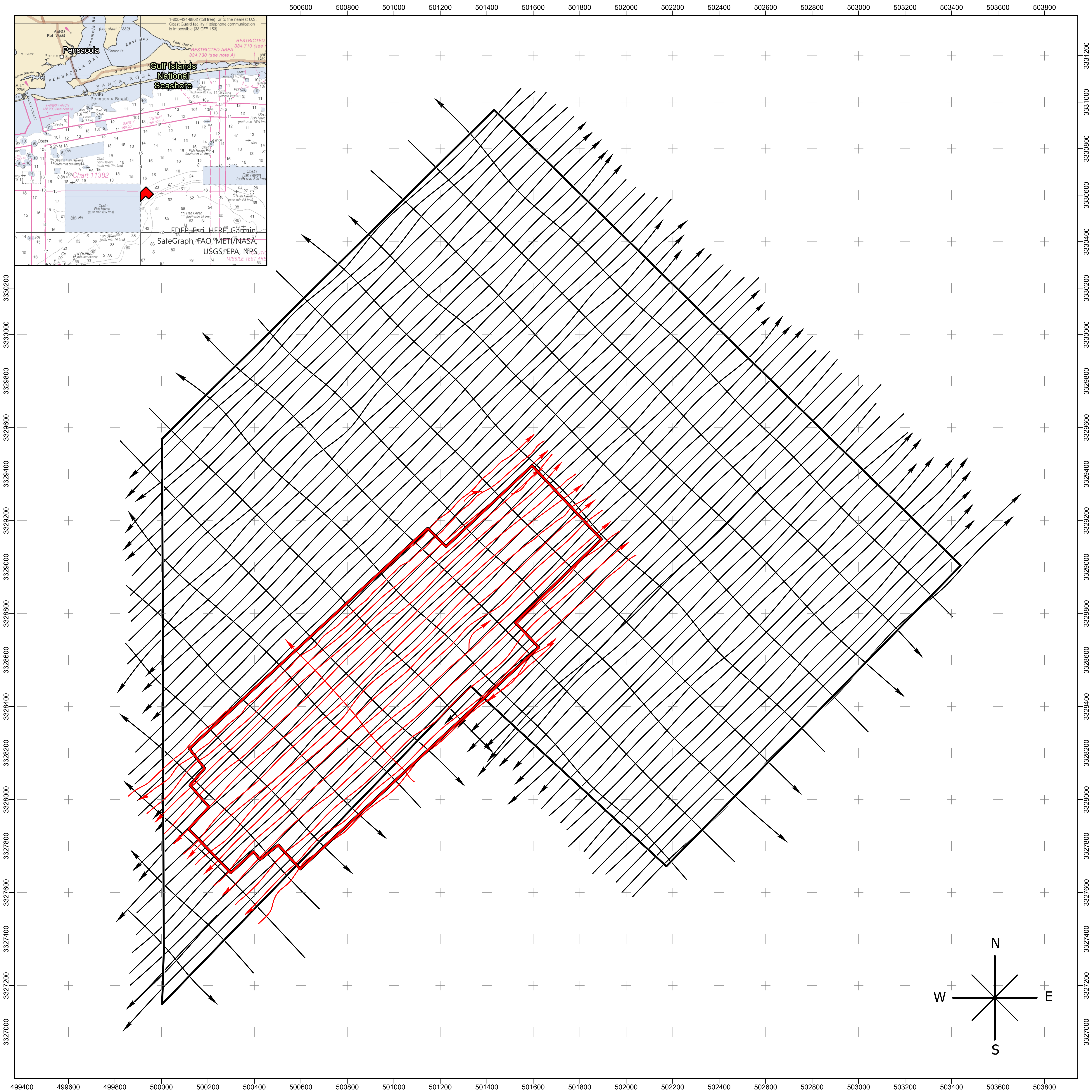
The County Medical Examiner should be immediately notified as to the findings. If the remains are found to be other than human, any construction will be cleared to proceed. If the remains are human, and are less than 75 years old, the Medical Examiner and local law enforcement officials will assume jurisdiction. If the remains are found to be human and older than 75 years, the State Archaeologist should be notified and may assume jurisdiction of the remains.

If jurisdiction is assumed by the State Archaeologist, he will (a) determine whether the human remains represent a significant archaeological resource, and (b) make a reasonable effort to identify and locate persons who can establish direct kinship, tribal community, or ethnic relationship with the remains. If such a relationship cannot be established, then the State Archaeologist may consult with a committee of four to determine the proper disposition of the remains. This committee shall consist of a human skeletal analyst, two Native American members of current state tribes recommended by the Governor's Council on Indian Affairs, and "an individual who has special knowledge or expertise regarding the particular type of the unmarked human burial."

A plan for the avoidance of any further impact to the human remains and/or mitigative excavation, reinterment, or a combination of these treatments will be developed in consultation with the State Archaeologist, the SHPO, and, if applicable, appropriate native American tribes or closest lineal descendants. All parties will be expected to respond with advice and guidance in an efficient time frame. Once the plan is agreed to by all parties, the plan will be implemented.

The point of contact for Florida is:

Timothy Parsons, Director and State Historic Preservation Officer
Florida Division of Historical Resources
R.A. Gray Building
500 S. Bronough St.
Tallahassee, FL 32399-0250
PH: 850-245-6333



Manna Fish Farms Offshore Aquaculture Site

Gulf of Mexico

Baseline Environmental Survey

MAP 1: SURVEY TRACKLINES

LEGEND

- Outline of Geophysical Survey Area (100% Side Scan Coverage)
- Outline of Proposed Aquaculture Sites (100% Multibeam Bathymetric Coverage)
- Geophysical Survey Tracklines
- Hydrographic Survey Tracklines

NOTES

1. Baseline Environmental Survey conducted 8-10 December 2020 by the Marine Services Division of David Evans and Associates, Inc.

2. Coordinates are in meters relative to North American Datum of 1983 (NAD83), Universal Transverse Mercator (UTM) Zone 16 North.

3. Overview map is National Oceanic and Atmospheric Administration (NOAA) chart 11360 with depths in fathoms.

0 750 1,500 2,250 3,000

Distance in US Feet

0 250 500 750 1,000

Distance in Meters

Map Scale 1:12,000

DAVID EVANS AND ASSOCIATES INC.

14231 Seaway Road, Suite 4002
Gulfport, MS 39503
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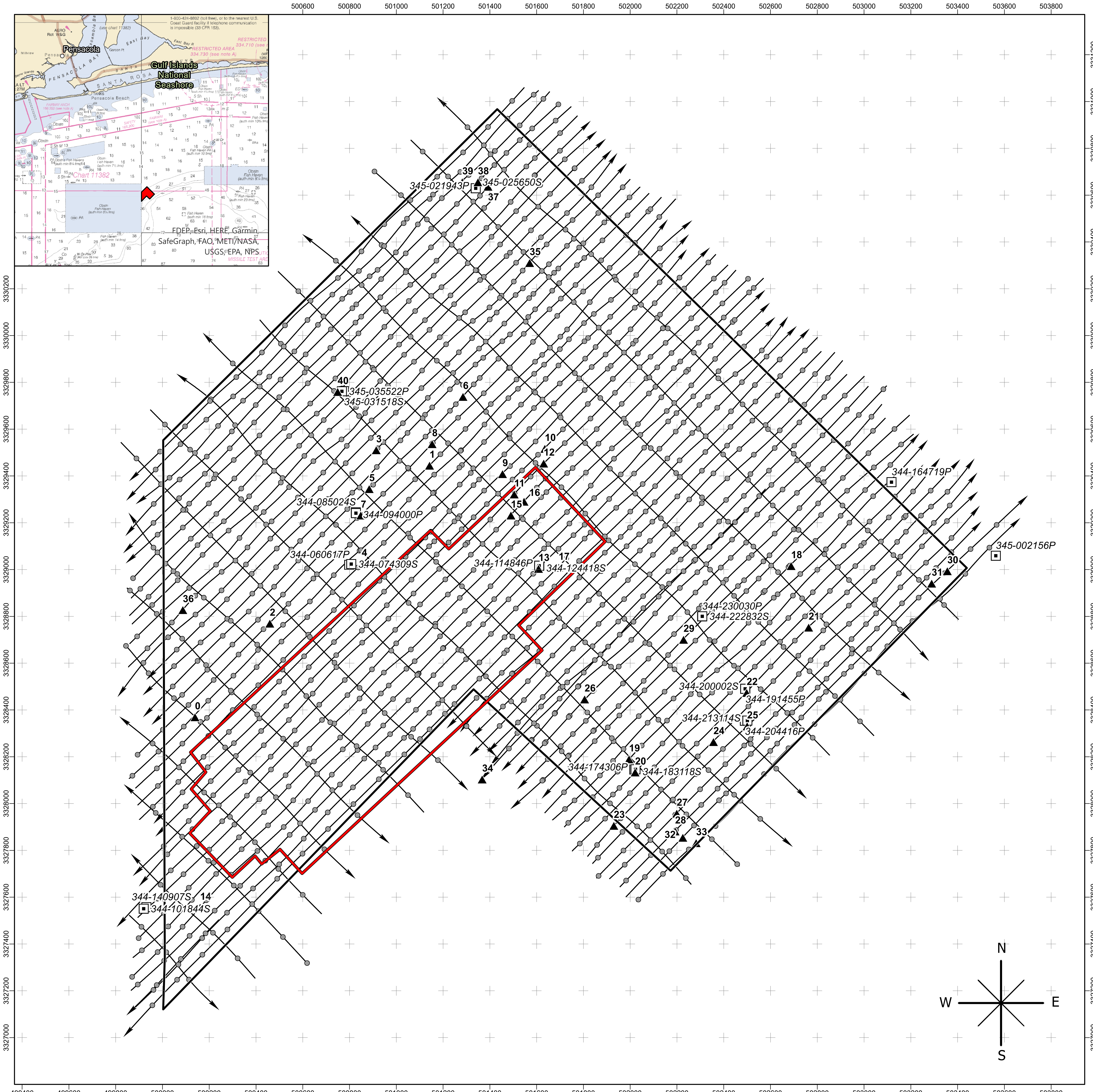


Manna Fish Farms Offshore Aquaculture Site

Gulf of Mexico

Baseline Environmental Survey

MAP 2: SIDE SCAN SONAR CONTACTS AND MAGNETIC ANOMALIES

LEGEND

Outline of Geophysical Survey Area (100% Side Scan Coverage)

Outline of Proposed Aquaculture Sites (100% Multibeam Bathymetric Coverage)

Geophysical Survey Tracklines with Shot Points at 500 foot (152 meter) Interval

ID Side Scan Sonar Contact and Identifier

ID Magnetic Anomaly and Identifier

NOTES

1. Baseline Environmental Survey conducted 8-10 December 2020 by the Marine Services Division of David Evans and Associates, Inc.

2. Coordinates are in meters relative to North American Datum of 1983 (NAD83), Universal Transverse Mercator (UTM) Zone 16 North.

3. Overview map is National Oceanic and Atmospheric Administration (NOAA) chart 11360 with depths in fathoms.

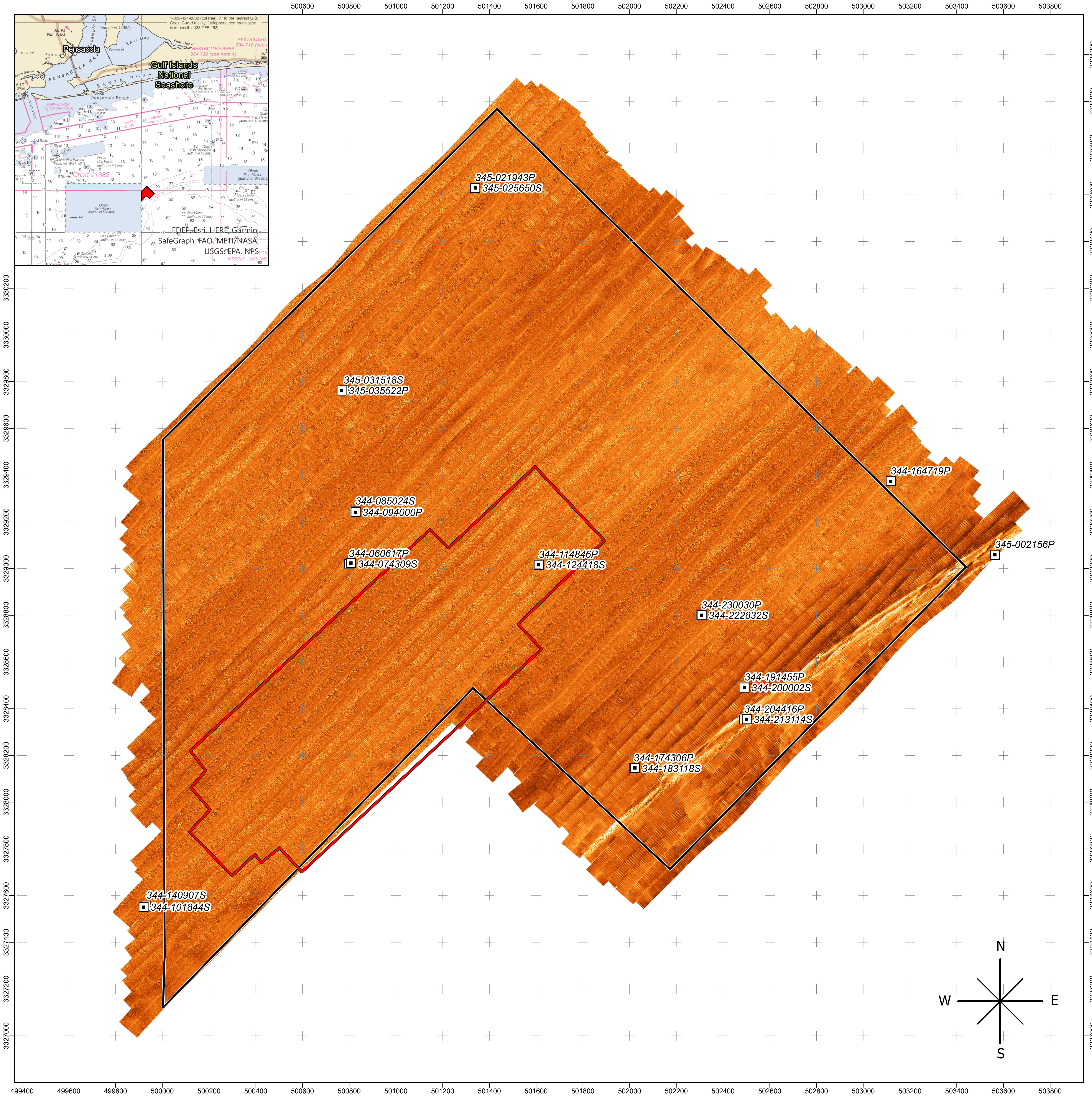
0 750 1,500 2,250 3,000
Distance in US Feet

0 250 500 750 1,000
Distance in Meters

Map Scale 1:12,000

DAVID EVANS AND ASSOCIATES INC.

14231 Seaway Road, Suite 4002
Gulfport, MS 39503
www.deainc.com



Manna Fish Farms Offshore Aquaculture Site

Gulf of Mexico

Baseline Environmental Survey

MAP 3:
SIDE SCAN SONAR MOSAIC AND CONTACTS

LEGEND

Outline of Geophysical Survey Area

Outline of Proposed Aquaculture Sites

ID

Side Scan Sonar Contact and Identifier

Acoustic Reflectivity

LOW HIGH

NOTES

1. Baseline Environmental Survey conducted 8-10 December 2020 by the Marine Services Division of David Evans and Associates, Inc.

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3. Overview map is National Oceanic and Atmospheric Administration (NOAA) chart 11360 with depths in fathoms.

0 750 1,500 2,250 3,000

Distance in US Feet

0 250 500 750 1,000

Distance in Meters

Map Scale 1:12,000

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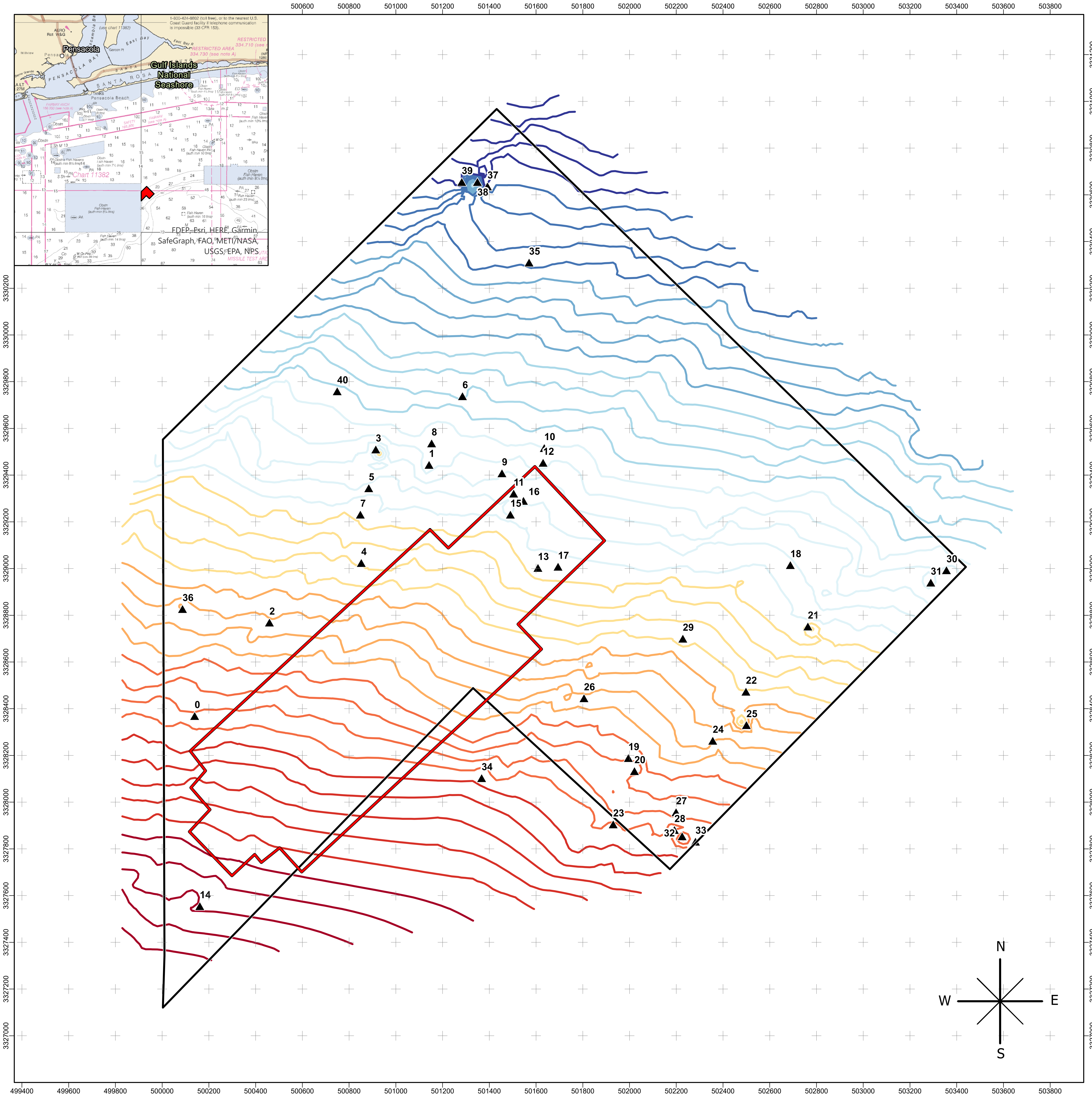

Manna Fish Farms Offshore Aquaculture Site

Gulf of Mexico

Baseline Environmental Survey

MAP 4: TOTAL MAGNETIC FIELD AND MAGNETIC ANOMALIES

LEGEND

Outline of Geophysical Survey

Outline of Proposed Aquaculture Sites

ID Magnetic Anomaly and Identifier

Total Magnetic Field Contours (nanoTeslas)

- ≤47378
- ≤47382
- ≤47386
- ≤47390
- ≤47395
- ≤47399
- ≤47403
- ≤47407
- ≤47412
- ≤47417

NOTES

1. Baseline Environmental Survey conducted 8-10 December 2020 by the Marine Services Division of David Evans and Associates, Inc.

2. Coordinates are in meters relative to North American Datum of 1983 (NAD83), Universal Transverse Mercator (UTM) Zone 16 North.

3. Overview map is National Oceanic and Atmospheric Administration (NOAA) chart 11360 with depths in fathoms.

4. Total magnetic field corrected for diurnal variations using shore-based magnetometer at Stennis Space Center, Mississippi.

0 750 1,500 2,250 3,000
Distance in US Feet

0 250 500 750 1,000
Distance in Meters

Map Scale 1:12,000

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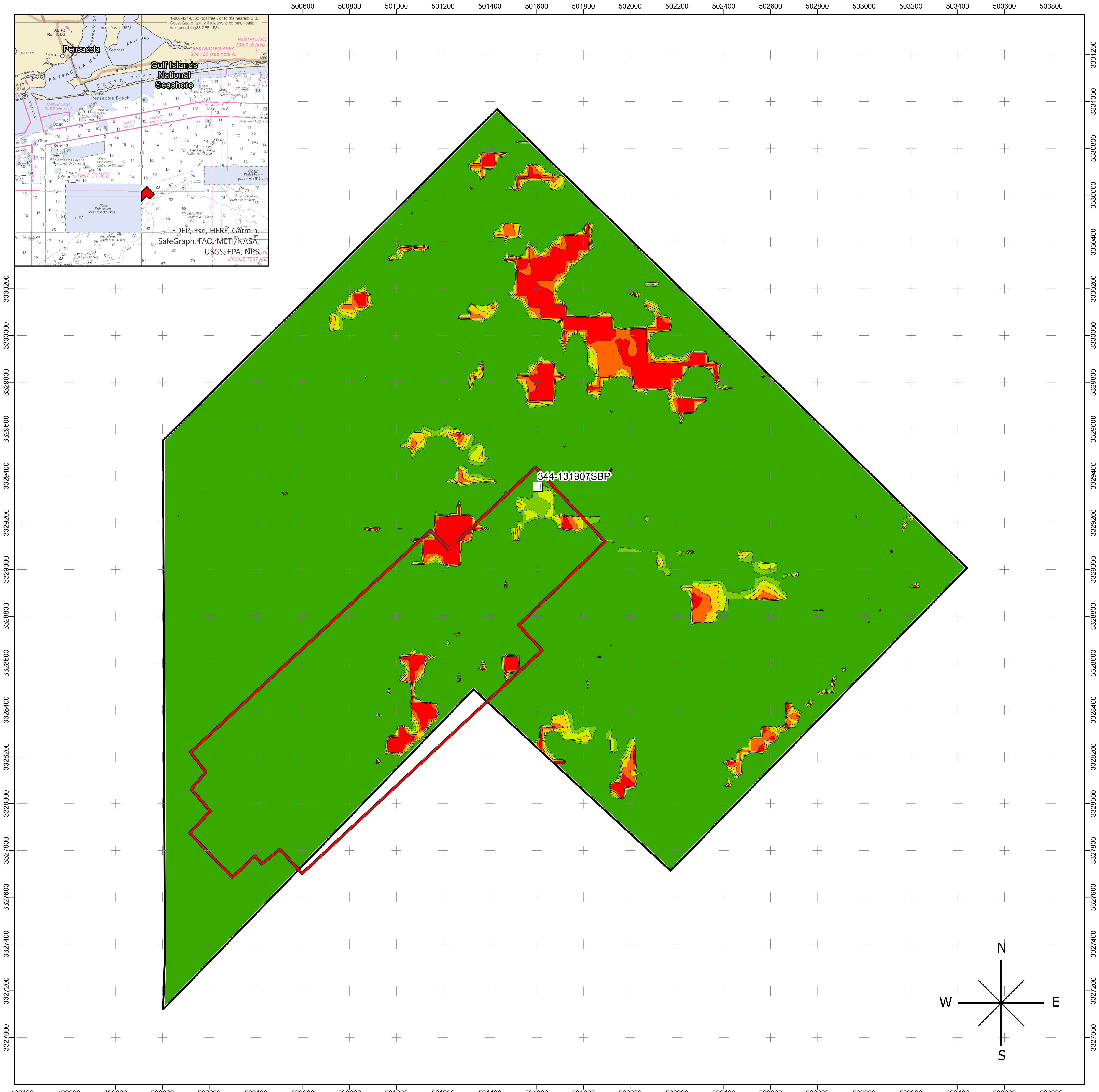

Manna Fish Farms Offshore Aquaculture Site

Gulf of Mexico

Baseline Environmental Survey

MAP 5: UNCONSOLIDATED SEDIMENT THICKNESS ISOPACH

LEGEND

Outline of Geophysical Survey

Outline of Proposed Aquaculture Sites

ID Subbottom Contact and Identifier

Approximate Unconsolidated Sediment Thickness (meters)

- >3-5
- 6
- 7
- 8
- 9
- 10

NOTES

1. Baseline Environmental Survey conducted 8-10 December 2020 by the Marine Services Division of David Evans and Associates, Inc.

2. Coordinates are in meters relative to North American Datum of 1983 (NAD83), Universal Transverse Mercator (UTM) Zone 16 North.

3. Overview map is National Oceanic and Atmospheric Administration (NOAA) chart 11360 with depths in fathoms.

0 750 1,500 2,250 3,000

Distance in US Feet

0 250 500 750 1,000

Distance in Meters

Map Scale 1:12,000

DAVID EVANS AND ASSOCIATES INC.

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Appendix I:

Hydrodynamic Engineering Report for StormSafe® Net Pen in the GOM

Kelson Marine Co.
PO Box 981
Scarborough, ME 04070

T +1 207-747-2090
KelsonMarine.com
Service@KelsonMarine.com

Loading and Motion Analysis of the StormSafe System at the Manna Fish Farms Gulf of Mexico Site

May 10, 2021

For: The University of New Hampshire, Manna Fish Farms, and Mike Meeker.

Revision	Date	Originator(s)	Description
0	March 2, 2021	Tobias Dewhurst, PhD, PE Michael MacNicoll, EIT	Submitted for review
1	March 5, 2021	Tobias Dewhurst, PhD, PE Michael MacNicoll, EIT	Correct node buoy net buoyancy in Tables 6 and 7.
2	March 26, 2021	Tobias Dewhurst, PhD, PE Michael MacNicoll, EIT	Added sections 5.1.4 and 5.1.5
3	April 30, 2021	Tobias Dewhurst, PhD, PE Michael MacNicoll, EIT	Updated mooring design, optimized for GOM site under 50-year storm conditions.
4	May 6, 2021	Tobias Dewhurst, PhD, PE Michael MacNicoll, EIT	Added section 4.1.1 Minor edits
5	May 11, 2021	Tobias Dewhurst, PhD, PE Michael MacNicoll, EIT	Added summary of 100-yr. analysis. Section 5.1.4 edits.

Table of Contents

1 Executive Summary

The purpose of this engineering evaluation was to (1) mitigate the risk of structural failure, (2) evaluate the proposed mooring system of the StormSafe finfish aquaculture cage for the proposed deployment location, and (3) propose an optimized mooring and anchoring layout. The farm system considered was proposed by Manna Fish Farms for a site approximately 25 miles southeast of Pensacola, FL.

Kelson Marine Co. ("Kelson") calculated extreme current, wave, and wind conditions corresponding to a storm that would occur once every 50-years (the 50-year storm), based on nearby historical ocean observations and industry standards. The 50-year significant wave height was calculated to be 12.2 m (40.0 ft), and the 50-year current speed was calculated to be 2.04 m/s (6.7 ft/s or 4.0 kts). Kelson then constructed a numerical model of the proposed system to investigate its response to waves, wind, currents, tidal variation, and storm surge.

To mitigate the risk of structural failure in extreme storms, key components of the system must meet or exceed the required structural capacities reported in Table 11. Required capacities for the mooring lines and bridle lines are 1,872 kN (426 kpf) and 1,870 kN (425 kpf), respectively. The anchor holding capacity must be 1,978 kN (450 kpf) and 482 kN (110 kpf) in the horizontal and vertical directions, respectively.

The present design utilizes drag embedment anchors. Uplift load angles on the anchors were in some cases allowed to exceed 20°, but in the peak design load scenario the uplift angle was less than 16°. The design standards used for this evaluation allow for uplift on embedment anchors provided (1) that high-efficiency drag embedment anchors are used, (2) anchor holding capacity reduction factor be applied, and (3) the soil type be soft clay to ensure deep penetration, and (4) the uplift angle less than 20° under the maximum design environment. Because the soil composition is not precisely known but is believed to be primarily sand, Kelson recommends that the vertical holding capacity of the anchors be proof tested after installation of the anchors and prior to installation of the cage.

A study of the StormSafe cage and its initial mooring system was completed for 100-year storm conditions of 12.9 m (42.3 ft) significant wave height and 2.39 m/s (7.8 ft/s or 4.6 kts) in the Gulf of Mexico. The study evaluated the suitability of the initial mooring system for open ocean use. Based on the results of that initial study and the incorporation of site specific characteristics, it was decided that an optimized mooring system would be designed and evaluated using aquaculture standard recommendations of a 50-year return period.

2 Introduction

2.1 Goal and Objectives

This report summarizes an engineering analysis of the proposed StormSafe aquaculture farm deployment near Pensacola, FL.

The primary goal of this analysis was to determine the required capacities of the structural members of the farm moorings, including the mooring lines, bridles, and anchors. Secondary goals included dimensioning the mooring system to mitigate the likelihood of seabed contact in extreme storms while accommodating operational requirements and the spatial constraints of the site.

To reduce the vertical anchor loads and the sizes of Corner Float buoys, further engineering analysis was undertaken to revise the original design in version 3 of this report.

These goals were achieved by the following objectives:

- Quantify extreme current, wave, and wind conditions corresponding to storms that would occur once every 50-years (the 50-year conditions).
- Construct a numerical dynamic model of the system.
- Quantify the required capacities of mooring lines and anchors under various combinations of 50-year conditions, allowing for industry-standard safety factors.
- Quantify the maximum submerged depth of the cage under various combinations of 50-year conditions.

2.2 Design Basis: Relevant Standards and Extreme Condition Return Period

Several industry and government standards exist for finfish aquaculture and relevant ocean engineering applications. Examples include:

- "Basis-of-Design Technical Guidance for Offshore Aquaculture Installations in the Gulf of Mexico" by the U.S. Dept. of Commerce's National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office. (Fredriksson & Beck-Stimpert, 2019a)
- NS 9415: "Marine fish farms–Requirements for site survey, risk analyses, design, dimensioning, production, installation and operation" (Standards Norway, 2009).
- "A Technical Standard for Scottish Finfish Aquaculture" (Ministerial Group for Sustainable Aquaculture's Scottish Technical Standard Steering Group, 2015)
- "Guidance Notes on the Application of Fiber Rope for Offshore Mooring" (ABS, 2012).
- "Design and analysis of station keeping systems for floating structures" (API, 2005)
- "Interim Guidance on Hurricane Conditions in the Gulf of Mexico" (American Petroleum Institute, 2007)
- "Offshore Anchor Data for Preliminary Design of Anchors of Floating Offshore Wind Turbines" (ABS, 2013)

NS9415 and the Scottish standard mandate that structures be designed to withstand 50-year storms.

Table 1 shows the elements of NOAA's Basis-of-Design Technical Guidance that were addressed for the StormSafe mooring system in the present analysis.

Table 1. Design-Bases Elements Addressed in the Present Report.

Design-Basis Elements	Addressed in Present Report
Site characteristics and environmental conditions.	Yes, minus seafloor survey
System analysis and loading.	Yes
Design factors to address uncertainty.	Yes
Replacement period and risk.	No
Specification of components.	Minimum required capacities and representative component sizes quantified
System layout and technical drawings.	Yes
Auxiliary equipment.	No
Deployment and operational protocols.	No
Operations and Maintenance (O&M) procedures	No

3 Site Parameters and Extreme Metocean Conditions

3.1 Location

The location of the site (Site E) is 30^o 4’ 60” N, 86^o 58’ 60” W, shown in Figure 1. The National Oceanic and Atmospheric Administration (NOAA) maintains several National Data Buoy Center (NDBC) metocean stations nearby which provide real-time monitoring and historical records of local ocean conditions. Station NDBC 42012 contains historical wave data back to 2009. Station NDBC 42067 contains historical current records from 2015-2016, and 2019-Aug. 2020. An Acoustic Doppler Current Profiler (ADCP) was also deployed at the site to collect current measurements in September 2019. These data sources were used to compute estimated extreme values used for the present analysis.

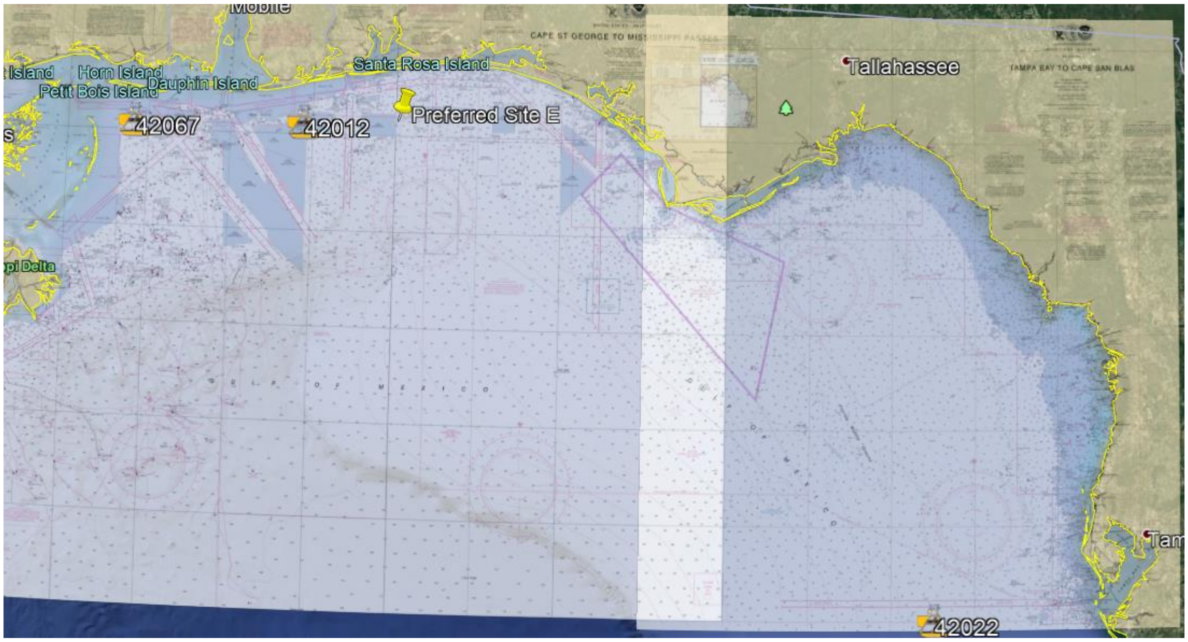


Figure 1. Location of proposed Site E. Location of NDBC buoys 42012 and 42067. Sources: Google, Data SIO, NOAA, U.S. Navy, NGA, GEBCO.

3.2 Water Depth

The permitted zone contains water depths ranging from 42 m (138 ft) to 50 m (164 ft), MLLW. All numerical analysis was conducted over both extreme depths.

3.3 Currents

Water current velocity data were derived from a combination of NDBC data obtained from Station 42067, ADCP data collected at the site, and the American Petroleum Institute's (API) Interim Guidance on Hurricane Conditions in the Gulf of Mexico (American Petroleum Institute, 2007). The location of the NDBC station (30º 3' 0" N; 88º 34' 58.8" W) is shown in Figure 1.

Kelson obtained and processed NDBC data collected between 2015-2016 and March-August 2020 to estimate the current speed with a return period of one year. Currents at the site are a complex mix of tides, large-scale flows (with periods on the order of weeks), and short-duration current events. A one-year current speed was also estimated from the ADCP data.

Kelson further estimated the current speeds with return periods of 10 and 50 years using modified guidance from the API's guidance bulletin mentioned above. This bulletin provides extreme current estimates due to hurricanes in the Gulf of Mexico, as a function of location (longitude) and water depth.

The extreme current speeds from each of the three data sources are summarized in Table 2. In the present study, Kelson analyzed the response of the system to 1, 10, and 50-year currents.

Table 2: Predicted long-term current speeds at Site E from three sources: NDBC Station 42067, the ADCP deployed near Pensacola, and the API Bulletin for hurricane conditions in the Gulf of Mexico.

	Current Speed [m/s]		
Return Period [yrs.]	NDBC 42067	ADCP	API Bulletin
Mean		0.21	
99%		0.51	
1	0.80	0.91	
10	1.05	1.06	1.02
25	1.14	1.12	1.50
50	1.22	1.16	1.84
100	1.29	1.21	2.15

To incorporate recent trends and phenomena such as "double hurricanes", Kelson compared the API guidance with our estimate of the extreme current speeds at a similar site (NDBC Buoy 42022 located roughly 80 miles west of Tampa, FL). This data suggested that the API-recommended current speeds be increased by 11% to incorporate recent trends for shallow water sites in the eastern Gulf. The final adjusted speeds used in the analysis are shown in Table 3.

Table 3: Current speeds used by Kelson Marine Co. in mooring system analysis.

Return Period [yrs.]	Current Speed [m/s]
1	0.91
10	1.13
50	2.04
100	2.39

An example of current velocity over a one-month period is shown in Figure 2. Here, North and East are the directions the current is going toward. Peak current speed events are shown in Figure 3. Here, peaks are defined as speeds which are more than two standard deviations higher than the mean speed. A 24-hour minimum time separation between peaks was specified when identifying peaks.

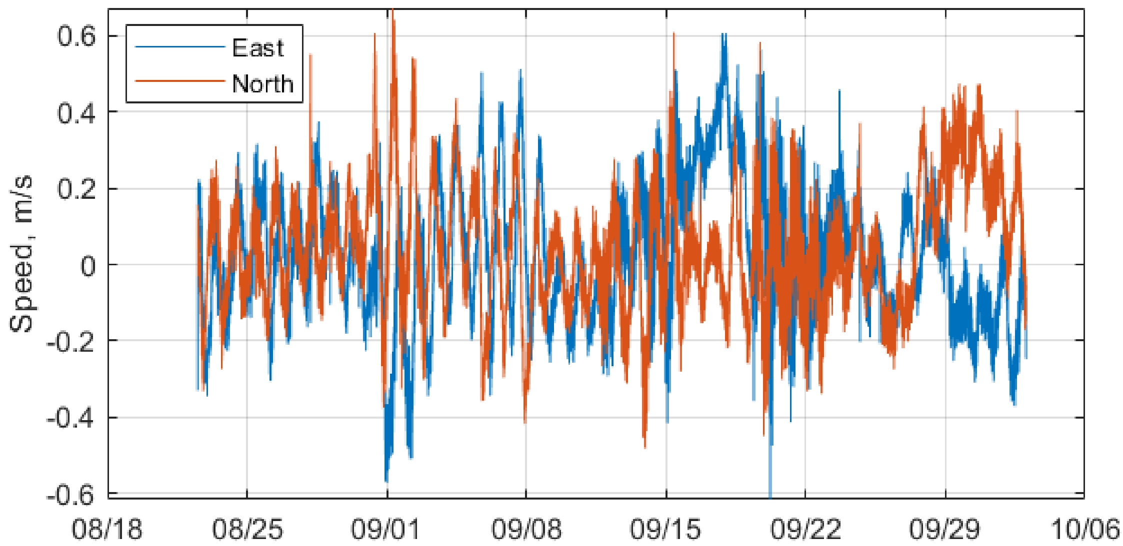


Figure 2. Current velocity for 2015-2016.

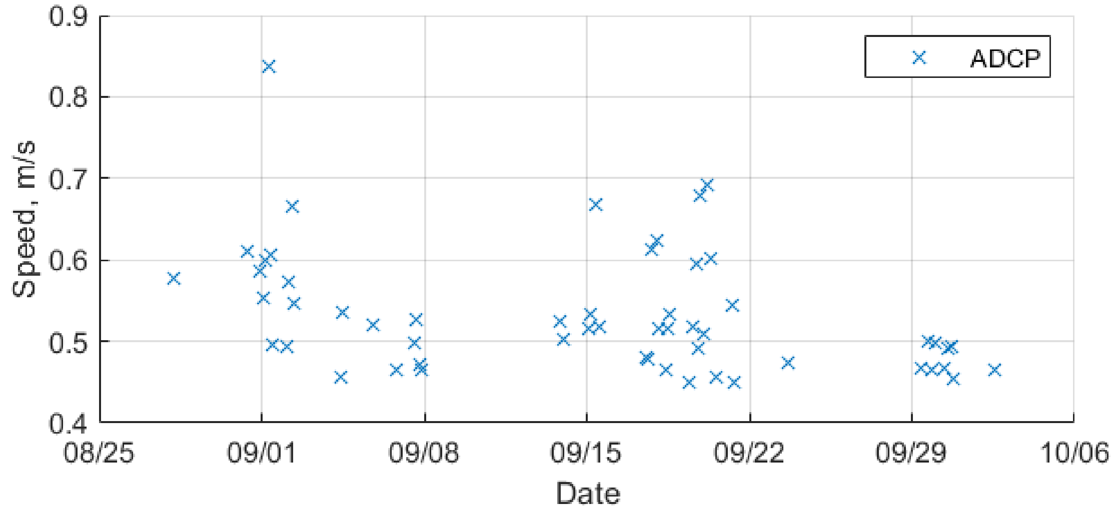


Figure 3. Peak observed current speeds at the site. Velocities are averaged over the nominal depth range occupied by the structure. Gaps in the data represent periods in which no useable data was collected. These gaps were accounted for when computing the extreme values.

The extreme values were computed by fitting peak observed current events to a Gumbel distribution and extrapolating. This fit, and the underlying data, are shown in Figure 4.

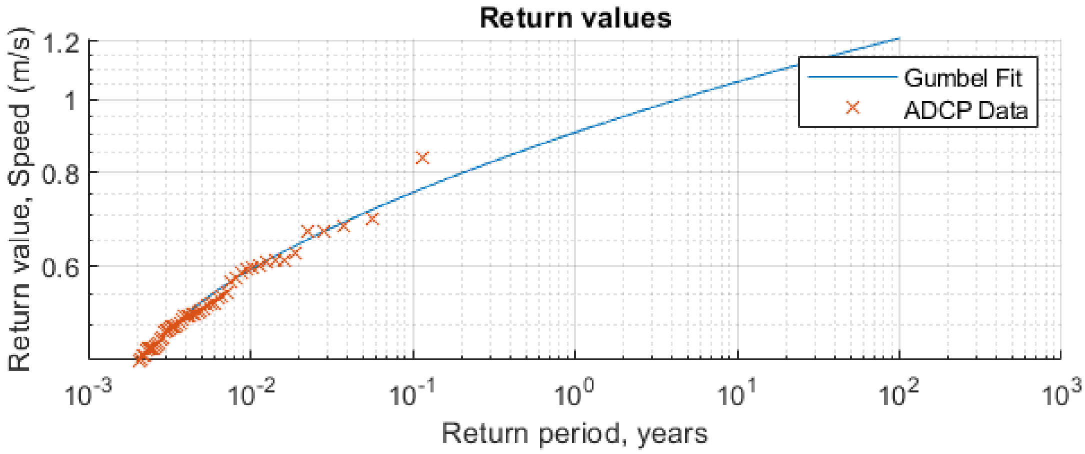


Figure 4. Extreme current speeds as a function of return period, in years. The Gumbel distribution was fitted to the observed data and extrapolated to the return periods of interest. The calculated 1-year current speed is 0.81 m/s (1.6 knots).

The directionality of the extreme currents was examined by plotting the probability of current speeds in each of 36 directional bins. The resulting "current rose" in Figure 5 shows that extreme current speeds are not constrained to a narrow directional band. Directions shown here indicate the direction current is coming <u>from</u>, for consistency with wave results.

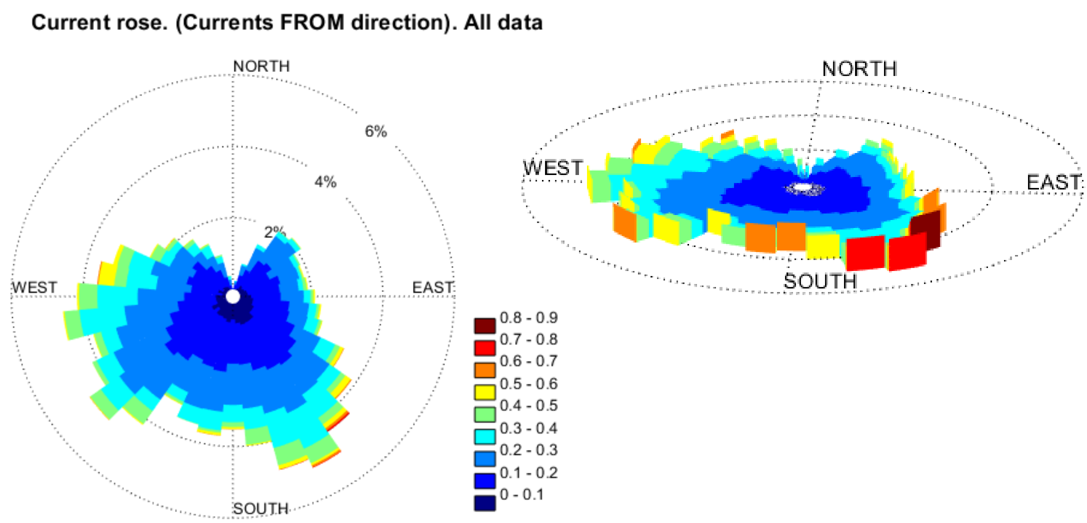


Figure 5. Current rose. Direction is the bearing that the current is coming <u>from</u>. The inset shows the same current rose, with heights proportional to current speed to highlight extreme speeds.

3.4 Waves

Typical wave statistics were derived from continuous, long-term wave observations from NDBC wave buoy station 42012, located at 30° 3' 50.4" N; 87° 33' 3.6" W in 25.9 meters (85 ft) of water, shown in Figure 1. Historical data from this buoy was obtained for the period from 2009 to 2020. The observed sea-states are shown in Figure 6, along with probability contours. These contours show that the significant wave height is below 1.8 m 99% of the time.

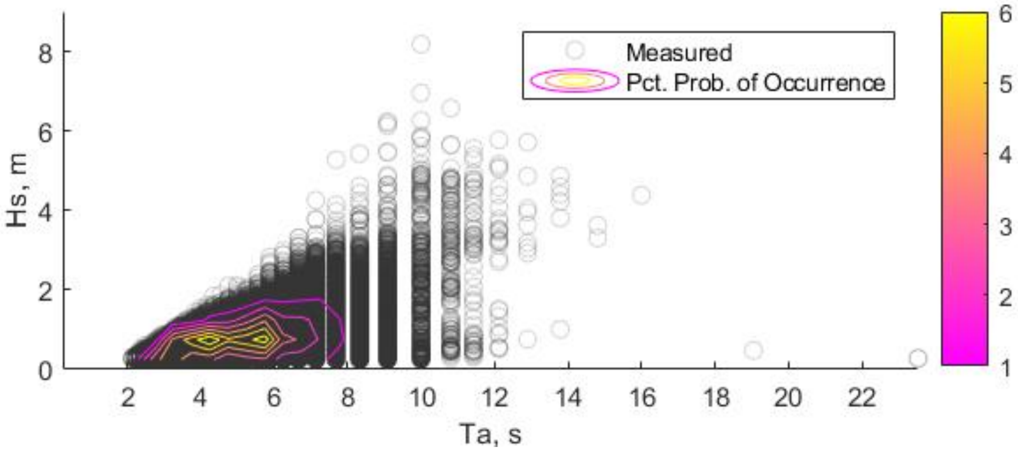


Figure 6. Historical wave data (black circles) as a function of peak wave period, T_{pk}, average wave period, T_a and significant wave height, H_s. The largest H_s on the 1% contour, is 1.77 m. This constitutes the 99% H_s.

The API Interim Guidance on Hurricane Conditions in the Gulf of Mexico (American Petroleum Institute, 2007) was also used to estimate extreme hurricane-induced wave conditions. This guidance was used to determine wave conditions with 10-year and 50-year return periods.

A Bretschneider wave spectrum was used to represent the 1-year wave condition. A JONSWAP (γ=2) wave spectrum was used to represent the 10-year and 50-year hurricane conditions. Directional wave spreading was modeled, as recommended in the API Bulletin.

The directionality of waves at the site was examined by plotting the probability of various wave heights occurring in each of 36 directional bins. Directions indicate the direction waves are coming from. The resulting "wave rose" in Figure 7 shows that waves are predominantly from the South-Southeast. Extreme waves can come from the Southwestern to Southeastern directions.

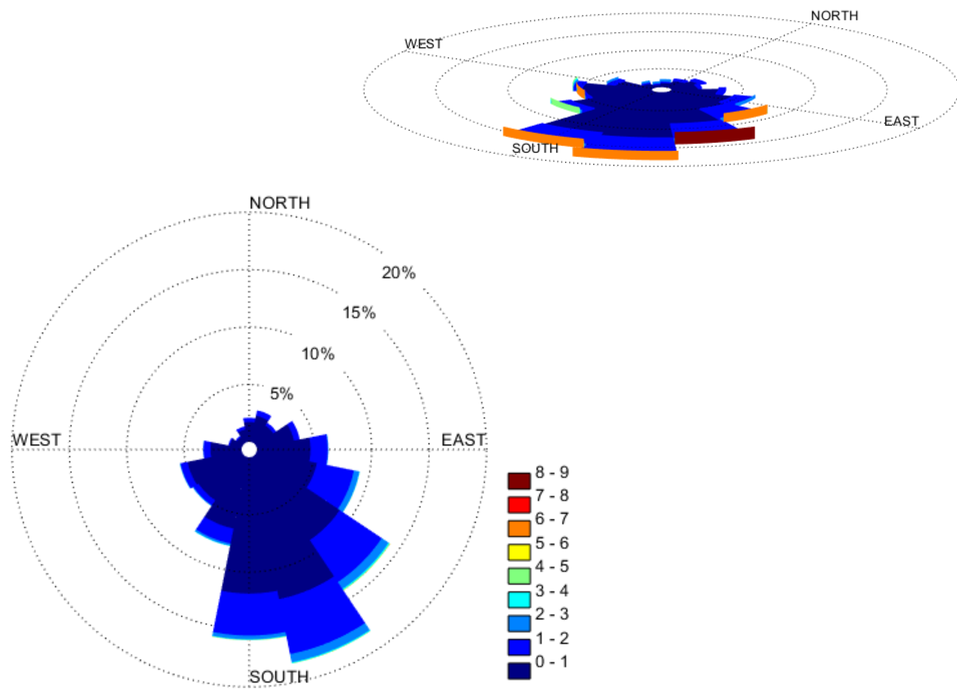


Figure 7. Probability of significant wave height, Hs, as a function of direction. Direction is the direction waves are coming from, relative to true north. The inset shows the same wave rose, with graph height proportional to significant wave height to highlight extreme conditions.

Observed peak wave events were fit to a Gumbel distribution and extrapolated to compute the one-year extreme significant wave height. The corresponding dominant wave period was chosen to be the value that produces the steepest waves (closest to breaking wave conditions). This fit, and the underlying data, is shown in Figure 8. A summary of the wave conditions used in the mooring system analysis are in Table 4.

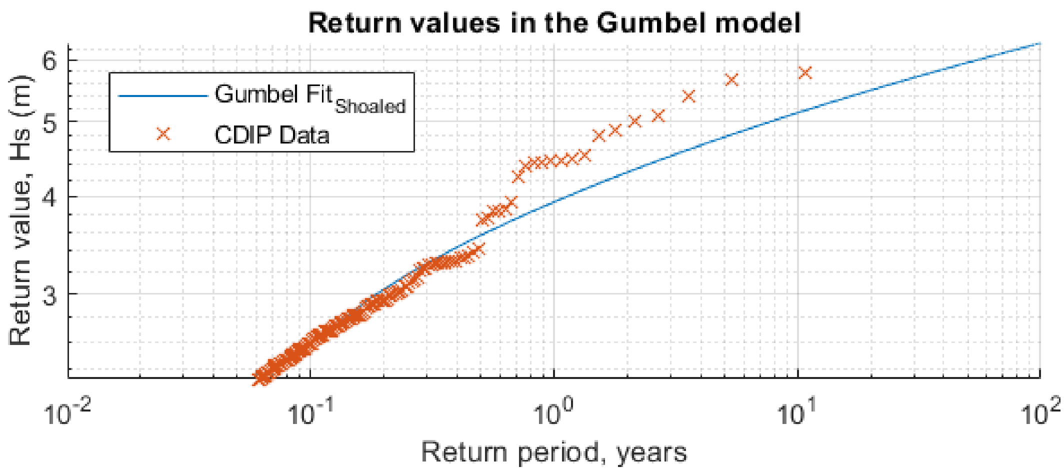


Figure 8: Extreme significant wave heights as a function of return period, in years. The Gumbel distribution was fitted to the observed data and extrapolated to the return periods of interest. The calculated 1-year wave height is 3.9 meters.

Table 4: Summary of extreme wave conditions used in mooring system analysis.

Return Period [yrs.]	Significant Wave Height [m]	Dominant Wave Period [s]	JONSWAP Gamma Factor	Directional Spreading Factor
1	3.9	5.9	1	1
10	8.2	13.0	2	2.5
50	12.2	15.0	2	2.5
100	12.9	15.4	2	2.5

3.5 Wind

The API Interim Guidance on Hurricane Conditions in the Gulf of Mexico (American Petroleum Institute, 2007) recommends constant wind speeds of 22.4 m/s and 28.4 m/s for 10-year and 50-year return periods, respectively at the Site E location. Those values represent the wind speeds at a height of one meter above the water level.

3.6 Tidal Range and Storm Surge

The API Interim Guidance on Hurricane Conditions in the Gulf of Mexico (American Petroleum Institute, 2007) recommends an increase in water depth of 1.7 meters above the mean lower low water (MLLW) depth to represent the combined 50-year storm surge and high tide.

3.7 Biofouling

As per Norwegian Standard 9415, biofouling was accounted for by increasing the effective diameter of the net twines by 50%.

3.8 Accidental Loads

Accidental loads considered were those in which one mooring leg is effectively severed due to (1) a failed mooring flotation element, (2), collision with service or other vessels, (3) failure of mooring lines, or (4) connector breakage. For each intact loadcase, the highest loaded mooring line was identified, and the system was subsequently analyzed with this mooring line broken.

Puncture scenarios, in which flotation elements in the cage system lose buoyancy, were not deemed relevant because all volumes in the cage structure are to be filled with seawater or foam in the extreme conditions.

3.9 Simulation Matrix

Table 5 shows the full matrix of load cases simulated by Kelson.

Table 5: Load cases simulated. Directions are headings waves and current are going toward, relative to mooring axis. All load cases were simulated with two water depths, as indicated.

Case	Water Depth [m]	Current Speed @ Surface [m/s]	Current Speed @ Seabed [m/s]	Current Direction [deg]	Sig. Wave Height [m]	Peak Wave Period [s]	Wave Direction [deg]	
1	50.0, 42.0	0.00	0.00	0	0.00	6.00	0	Calm water low tide
2	51.7, 43.7	0.00	0.00	0	0.00	6.00	0	Calm water high tide
3	50.0, 42.0	0.21	0.00	270	0.90	5.50	270	Mean conditions
4	50.0, 42.0	0.51	0.00	270	1.80	4.50	270	99% condition
5	50.0, 42.0	0.91	0.91	270	3.9	5.9	270	1-year wave & 1-year current aligned
6	50.0, 42.0	0.91	0.91	300	3.9	5.9	300	
7	51.7, 43.7	0.91	0.91	270	3.9	5.9	270	
8	51.7, 43.7	0.91	0.91	300	3.9	5.9	300	
9	51.7, 43.7	2.04	2.04	270	8.2	13.0	210	50-year storm surge; 10-year wave & 50-year current aligned
10	51.7, 43.7	2.04	2.04	330	8.2	13.0	270	
11	51.7, 43.7	2.04	2.04	300	8.2	13.0	240	
12	51.7, 43.7	2.04	2.04	0	8.2	13.0	300	
13	51.7, 43.7	1.13	1.13	270	12.2	15.0	210	50-year storm surge; 50-year wave & 10-year current
14	51.7, 43.7	1.13	1.13	330	12.2	15.0	270	
15	51.7, 43.7	1.13	1.13	300	12.2	15.0	240	
16	51.7, 43.7	1.13	1.13	0	12.2	15.0	300	
17	51.7, 43.7	1.13	1.13	270	10.9	15.0	270	50-year storm surge; 50-year wave & 10-year current aligned
18	51.7, 43.7	1.13	1.13	300	10.9	15.0	300	
19	50.0, 42.0	2.04	2.04	270	8.2	13.0	210	10-year wave & 50-year current aligned
20	50.0, 42.0	2.04	2.04	330	8.2	13.0	270	
21	50.0, 42.0	2.04	2.04	300	8.2	13.0	240	
22	50.0, 42.0	2.04	2.04	0	8.2	13.0	300	
23	50.0, 42.0	1.13	1.13	0	12.2	15.0	300	50-year wave & 10-year current
24	50.0, 42.0	1.13	1.13	330	12.2	15.0	270	
25	50.0, 42.0	1.13	1.13	300	12.2	15.0	240	
26	50.0, 42.0	1.13	1.13	0	12.2	15.0	300	
27	50.0, 42.0	1.13	1.13	270	10.9	15.0	270	50-year wave & 10-year current aligned
28	50.0, 42.0	1.13	1.13	300	10.9	15.0	300	

4 Dimensions and Numerical Model of the StormSafe Farm System

4.1 Farm dimensions

The structure dimensions proposed by Manna Fish Farms are shown in Figure 9 and Figure 10. The mooring footprint is shown in . A list of the components as evaluated is given in Table 6 (SI units) and Table 7 (US Customary units).

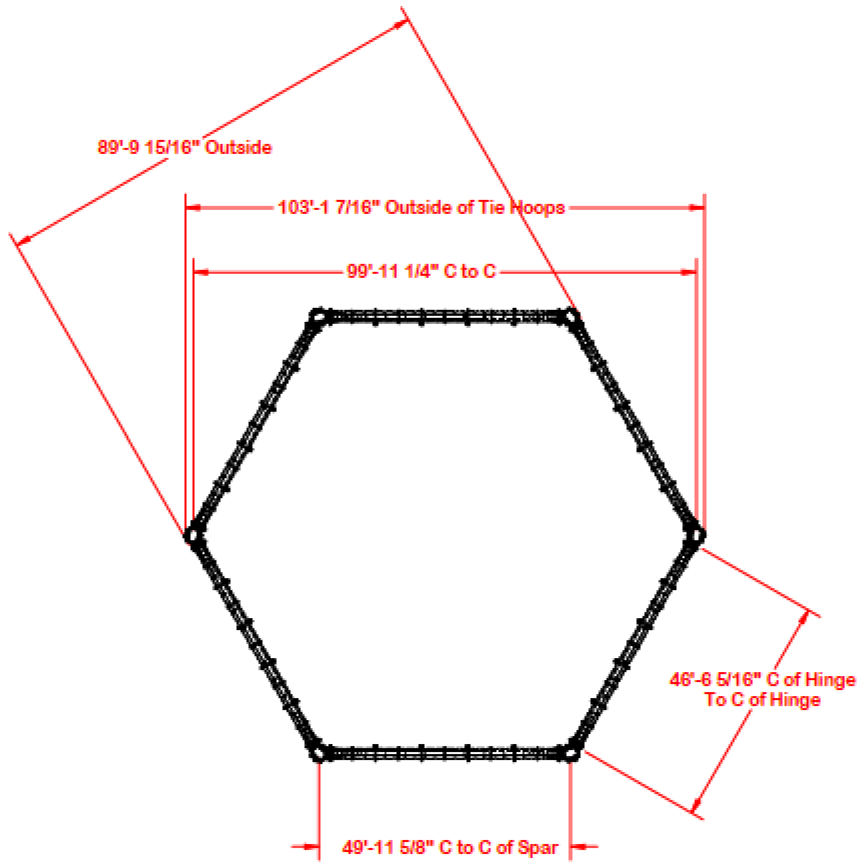


Figure 9. Plan view of farm system dimensions proposed by Manna Fish Farms[1].

[1] "Hex Cage W Pipe Walkways March 2017 #1-15.PDF"

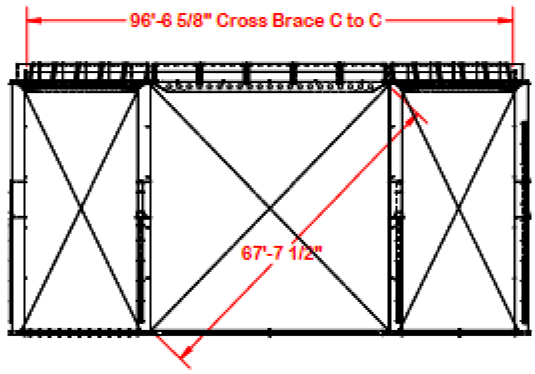


Figure 10. Side view of farm system dimensions proposed by Manna Fish Farms[2].

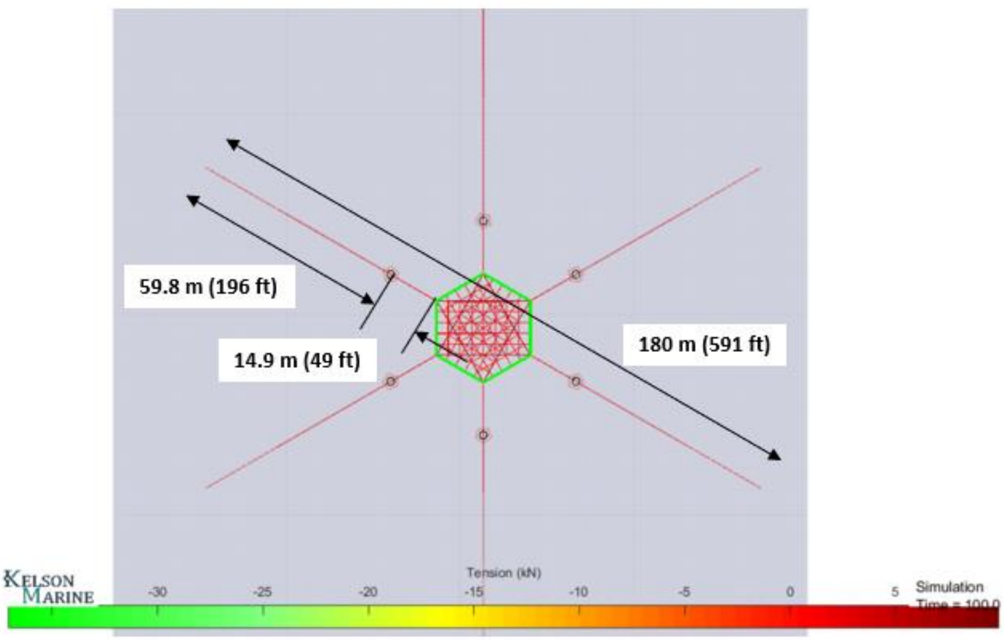


Figure 11: Plan view of farm system with mooring footprint shown.

[2] "Hex Cage W Pipe Walkways March 2017 #1-15.PDF"

Table 6. Farm components, as analyzed. SI Units.

Component	Material	Qty	Length Each [m]	Net Buoyancy Total for Material [kg]	Volume Each [m^3]
Anchor Chain	Studless Chain	6	27.4	-4,127	
Anchor Line	Polyester	6	58.3	-203.9	
Anchor	high efficiency drag embedment	6	3.7	3000	
Node Float	Ocean Guard MB-50	6	1.50	32,018	6.23
Node Tether	Polyester	6	0.1	-0.3	
Mooring Plate	Steel	6	0.05	-38	
Cage Bridle	Polyester	6	14.9	-52	
Cage Spar	Aluminum	6	15.1	-11,209	1.71E-01
Diagonal Side Brace	Steel	12	20.6	-215	
Diagonal Top Brace	Steel	3	30.5	-79	
Lower Connection Pipe	Steel	6	15.2	-3,961	8.10E-02
Pipe Walkway	Aluminum	6	15.2	-7,421	1.38E-01
Net w/ Fouling	210/120, 1.25" Nylon; Diameter increased 50% to account for fouling				

Table 7. Farm components, as analyzed. Customary Units.

Component	Material	Qty	Length Each [ft]	Net Buoyancy Total for Material [lbf]	Volume Each [ft^3]
Anchor Chain	Studless Chain	6	89.9	-1,876	
Anchor Line	Polyester	6	191.3	-678.5	
Anchor	high efficiency drag embedment	6	12.2	6,614	
Node Float	Ocean Guard MB-50	6	4.9	70,440	1.39E+03
Node Tether	Polyester	6	0.3	-0.7	
Mooring Plate	Steel	6	0.2	-83.8	
Cage Bridle	Polyester	6	48.9	-114.4	
Cage Spar	Aluminum	6	49.5	-24,711.6	6.04E+00
Diagonal Side Brace	Steel	12	67.6	-474.0	
Diagonal Top Brace	Steel	3	100.1	-174.2	
Lower Connection Pipe	Steel	6	49.9	-8,732.5	2.86E+00
Pipe Walkway	Aluminum	6	49.9	-16,360.5	4.87E+00
Net w/ Fouling	210/120, 1.25" Nylon; Diameter increased 50% to account for fouling				

4.1.1 Calm Water

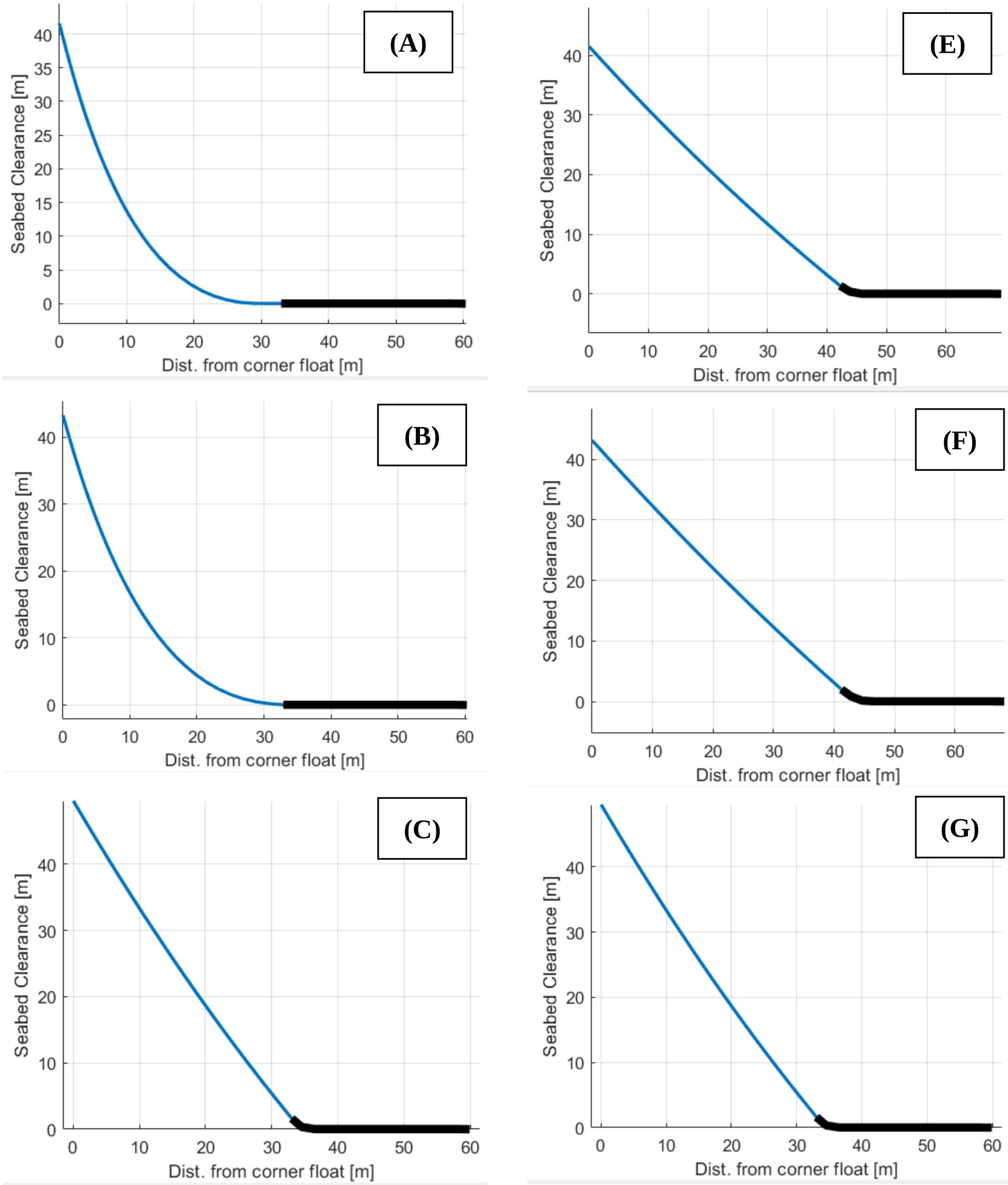
The calm water loads on the mooring and bridle lines are shown in Table 8 and Table 9, as well as the clearance distance between the bottom of the cage and the seabed. These values were evaluated in eight combinations of water depth and submergence. Figure 12 shows the catenary shape of a mooring leg in each of those eight conditions. The chain and synthetic rope sections are shown in black and blue, respectively. The chain has a length of 27.4 m (90 ft), and the rope has a length of 58.3 m (191.3 ft).

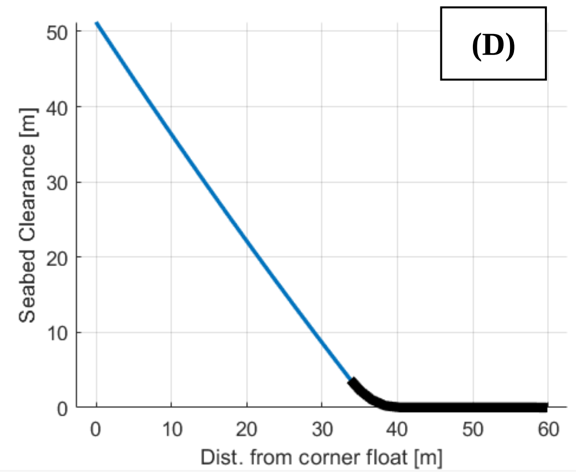
Table 8: Calm-water mooring loads and clearance between bottom of cage and seabed. SI Units.

	Condition	Submergence	Water Depth [m]	Mooring Tension [N]	Bridle Tension [N]	Cage-seabed Clearance [m]
A	MLLW	Surfaced	42.0	312	124	27.6
B	50-Yr Tide + Storm Surge	Surfaced	43.7	333	135	29.3
C	MLLW	Surfaced	50.0	1354	727	35.6
D	50-Yr Tide + Storm Surge	Surfaced	51.7	2607	1470	37.2
E	MLLW	Submerged	42.0	1704	3119	12.2
F	50-Yr Tide + Storm Surge	Submerged	43.7	2180	3245	14.4
G	MLLW	Submerged	50.0	4553	4116	23.5
H	50-Yr Tide + Storm Surge	Submerged	51.7	5387	4496	26.0

Table 9: Calm-water mooring loads and clearance between bottom of cage and seabed. US Customary units.

	Condition	Submergence	Water Depth [ft]	Mooring Tension [lbs]	Bridle Tension [lbs]	Cage-seabed Clearance [ft]
A	MLLW	Surfaced	137.8	70.1	27.9	90.6
B	50-Yr Tide + Storm Surge	Surfaced	143.4	74.9	30.3	96.1
C	MLLW	Surfaced	164.0	304.4	163.4	116.8
D	50-Yr Tide + Storm Surge	Surfaced	169.6	586.1	330.5	122.0
E	MLLW	Submerged	137.8	383.1	701.2	40.0
F	50-Yr Tide + Storm Surge	Submerged	143.4	490.1	729.5	47.2
G	MLLW	Submerged	164.0	1023.6	925.3	77.1
H	50-Yr Tide + Storm Surge	Submerged	169.6	1211.0	1010.7	85.3


(A)
Seabed Clearance [m]
Dist. from corner float [m]
(E)
Seabed Clearance [m]
Dist. from corner float [m]
(B)
Seabed Clearance [m]
Dist. from corner float [m]
(F)
Seabed Clearance [m]
Dist. from corner float [m]
(C)
Seabed Clearance [m]
Dist. from corner float [m]
(G)
Seabed Clearance [m]
Dist. from corner float [m]



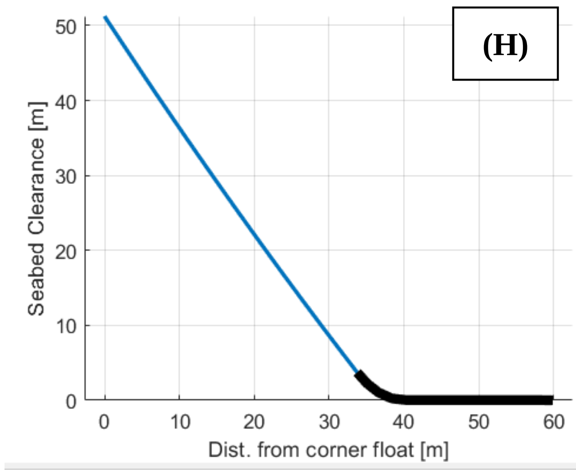


Figure 12: Calm-water catenary mooring layout in each of the eight conditions simulated. Blue line shows the synthetic rope portion of the mooring, while the dark black line is the chain portion. (A) surfaced, depth = 42.0 m; (B) surfaced, depth = 43.7 m; (C) surfaced, depth = 50.0 m; (D) surfaced, depth=51.7 m; (E) submerged, depth = 42.0 m (F) submerged, depth = 43.7 m; (G) submerged, depth = 50.0 m; (H) submerged, depth = 51.7.

4.2 Numerical Modeling Approach

The proposed farm is located in an exposed ocean site subject to wind, waves, and currents. Since the aquaculture system is comprised of flexible components subject to nonlinear wave and current forces, static analysis of the structure was not sufficient for determining the required structural capacity. Therefore, Kelson Marine Co. ("Kelson") developed a numerical model of the proposed structure which solves the equations of motion of each element at each time step using a nonlinear Lagrangian method to accommodate the large displacements of structural elements, as described in NOAA's Basis-of-Design Technical Guidance for Offshore Aquaculture Installations In the Gulf of Mexico (Fredriksson & Beck-Stimpert, 2019b). Wave and current loading on elements is incorporated into the model using a Morison equation formulation (Morison et al., 1950) modified to include relative motion between the structural element and the surrounding fluid. For elements intersecting the free surface, buoyancy, drag, and added mass forces are multiplied by the fraction of the element's volume that is submerged. Wave forcing and steady incident flow are specified by the user.

The net hydrodynamics were simulated using a method developed and validated by Kelson Marine that accounts for net solidity, instantaneous relative fluid speed, and incident flow angle on the net panels. This model was validated against full-scale field measurements by Gansel et al. (2018), as shown in Figure 13.

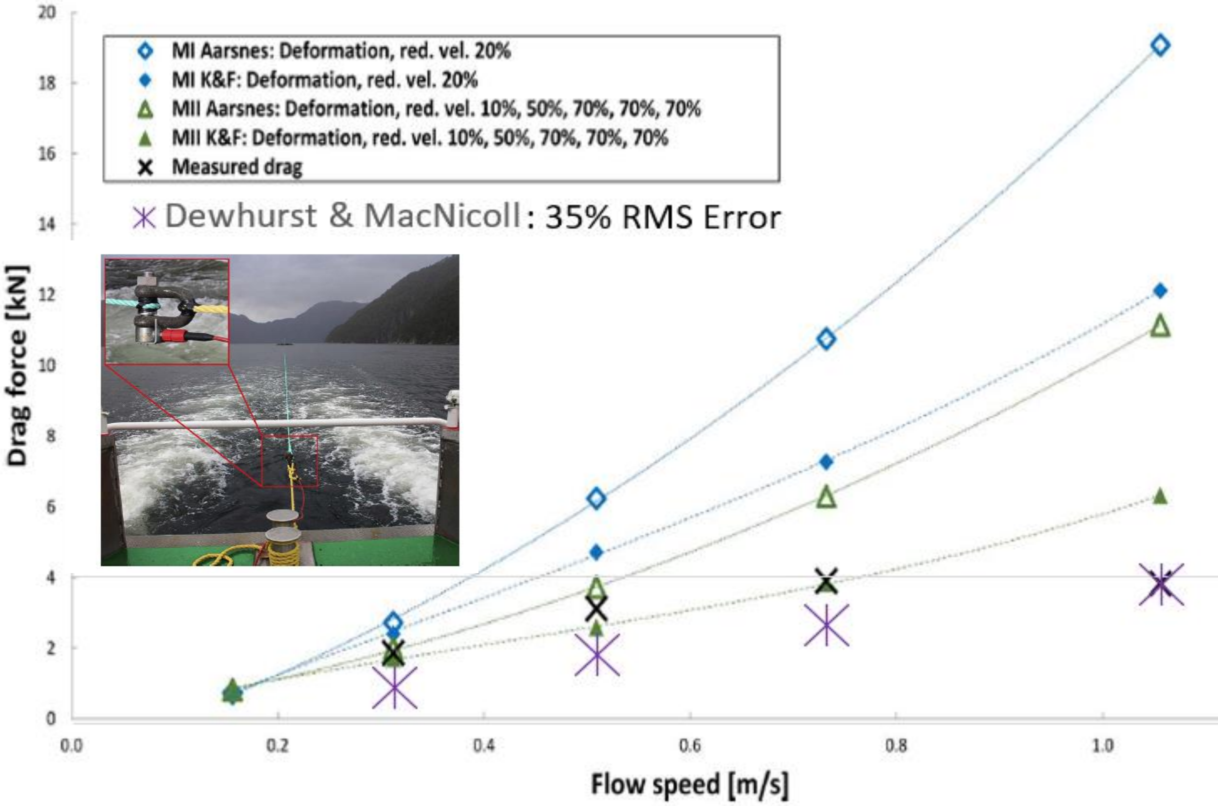


Figure 13. Validation of Kelson Marine's numerical modeling approach for net pen hydrodynamics at high fluid speeds. The method used in the present report (Dewhurst and MacNicoll) is within 35% RMS error of the drag force measured on a full-scale 6m deep by 12 m diameter cage towed at 0.3 – 1.05 m/s by Gansel et al. (2018). This method performs better than other modeling techniques as employed by Gansel et al. (2018), especially at the high fluid speeds most similar to those in the present design conditions. The 35% error is incorporated in capacity recommendations. INSET: Full-scale cage towing setup employed by Gansel et al. (2018).

The system was analyzed with the StormSafe cage in a surfaced position (Figure 14) in calm water and milder storm conditions (Case 1-8 in Table 5); and a submerged, ballasted position (Figure 15) in all storm conditions.

Since each cage unit in an array has its own anchors and is independent of the others, an individual system was examined.

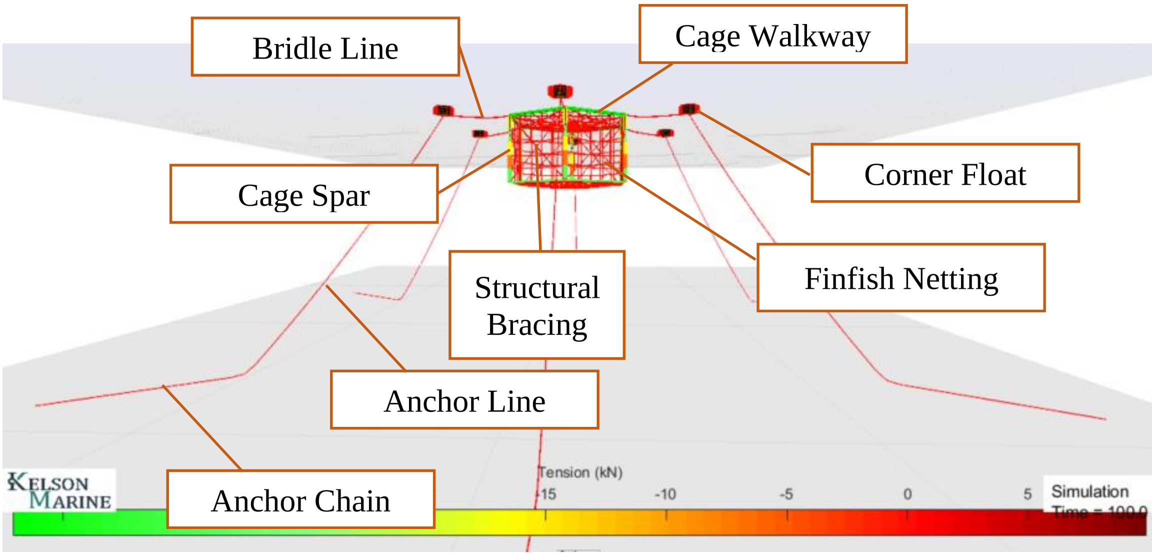


Figure 14. Hydro-/Structural Finite Element Analysis model of the proposed structure in surfaced position. The model computes the motions and the forces on each element of the farm (elements of the ropes, buoys, nets, and cage) at each instant in time, as a function of relative fluid velocity, acceleration, buoyancy, and internal forces.

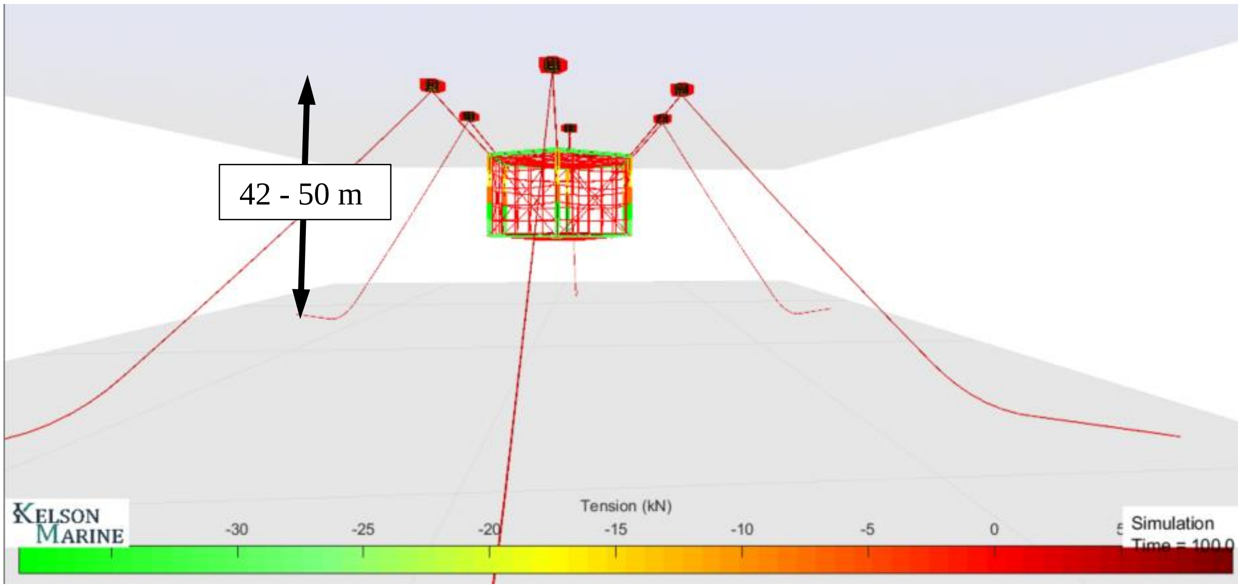


Figure 15. Hydro-/Structural Finite Element Analysis model of the proposed structure in submerged position. The model computes the motions and the forces on each element of the farm (elements of the ropes, buoys, nets, and cage) at each instant in time, as a function of relative fluid velocity, acceleration, buoyancy, and internal forces.

5 Results and Risk Mitigation

5.1 Mitigating the Risk of Structural Failure

5.1.1 Load cases Considered

NS9415 and the Scottish finfish standard mandate that structures be designed to withstand 50-year storms. They stipulate that two 50-year events should be examined: A) 50-year wave conditions combined with 10-year current conditions (the wave-dominated case) and B) 50-year current conditions combined with 10-year wave conditions (the current-dominated case). The 10-year or 50-year wind speed was included in all load cases, with the return period equaling the wave return period. Figure 16 shows a screenshot of the hydro-/structural dynamic FEA model of the StormSafe cage responding to a 50-year current and 10-year wind/wave storm.

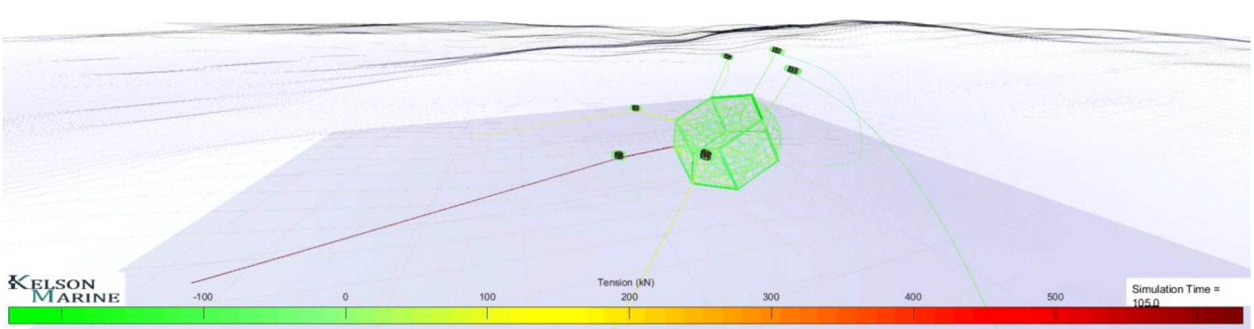


Figure 16. Dynamic model of StormSafe system in a 50-year storm (8.2 m significant wave height; current speed of 2.04 m/s). Waves and currents are aligned with adjacent mooring lines and misaligned by 60 degrees with each other.

5.1.2 Calculation of Required Structural Capacity

Kelson used an "allowable-stress design" approach to specific the required capacities of the mooring system. For each load case, the maximum expected tensions and forces in a one-hour storm, F_{max}, were calculated assuming an extreme value distribution of the maximum loads. This approach is equivalent to the method used to determine the one-year extreme significant wave height (see Figure 8).

A one-hour storm duration was selected because it matched the maximum NDBC sampling period. If longer storm durations were used, the computed extreme significant wave heights would be lower.

Kelson calculated the minimum breaking strength of the mooring components and the minimum holding power of the anchors required to achieve safety factors recommended by ABS and API for offshore structures. The American Bureau of Shipping (ABS) recommends a safety factor of 1.82 on synthetic ropes and 1.67 for chain (ABS, 2012). All safety factors were increased by a factor of 1.35 to account for the RMS error of the numerical validation. The anchor horizontal holding factor was further increased by 1.23 to account for uplift loads with an angle of 20^o when the load is at its maximum. The minimum safety factors that Kelson recommends for various mooring and anchor components are summarized in Table 10.

Taking into account the required safety factors, Kelson computed the minimum allowable capacity (e.g. breaking strength) of major structural components based on the results of the dynamic simulations of the system in the 50-year storm conditions. These are tabulated in Table 11 (Intact condition; SI units), Table 12 (Intact condition; US Customary units), Table 13 (Broken line condition; SI units), and Table 14 (Broken line condition; US Customary units). The required structural capacities are summarized in Table 15 and Table 16.

Table 10: Safety factors and anchor capacity factors applied. Values are based on the American Bureau of Shipping with an additional model validation factor applied.

	Scenario	
	All Intact	One Line Broken
Chain and Steel Components	2.3	1.7
Fiber Rope	2.5	1.9
Anchor Holding Capacity		
Horizontal	2.7	2.5
Vertical	2.7	2.0

Table 11. Minimum allowable capacity (e.g. minimum breaking strength) of major structural components in extreme storm conditions with all lines intact. Recommended safety factors are included. When purchasing ropes, the breaking strength must equal or exceed the requirements shown below. The definition of minimum breaking strength of selected ropes must include reductions in strength due to knots or splicing. SI Units

	Case	Mooring Tension Rope [kN]	Mooring Tension Chain [kN]	Bridle Tension [kN]	Anchor Capacity Horizontal [kN]	Anchor Capacity Vertical [kN]	Anchor Uplift [deg]
Surfaced	1	3.1	3.3	1.8	1.9	0	0
Surfaced	2	5.9	6.4	3.6	3.9	0	0
Surfaced	3	65.4	71.3	69.6	69.3	18.2	14.7
Surfaced	4	274.1	298.7	271.9	294.1	171.1	30.2
Surfaced	5	668.6	728.6	587.5	741.9	291.8	21.5
Surfaced	6	497.6	542.3	398.7	542.3	234.1	23.3
Surfaced	7	647.9	706.1	652.2	716.4	290.0	22.0
Surfaced	8	512.4	558.4	472.0	558.0	251.9	24.3
Submerged	1	11.2	10.3	10.1	7.8	0	0
Submerged	2	13.2	12.1	11.0	9.2	0	0
Submerged	3	65.3	59.9	90.5	64.5	20.2	17.3
Submerged	4	222.1	203.8	248.5	215.3	120.9	29.3
Submerged	5	498.9	457.8	450.0	508.7	199.8	21.4
Submerged	6	381.9	350.4	339.1	385.3	144.2	20.5
Submerged	7	468.3	429.7	427.6	475.4	206.5	23.5
Submerged	8	352.2	323.2	312.0	332.2	139.1	22.7
Submerged	9	1703.0	1562.7	1759.0	1830.5	304.9	9.5
Submerged	10	1698.6	1558.6	1682.2	1825.5	306.2	9.5
Submerged	11	1439.6	1320.9	1428.0	1547.9	239.9	8.8
Submerged	12	1411.1	1294.8	1399.8	1517.2	233.7	8.8
Submerged	13	1224.7	1123.8	1223.8	1284.0	416.6	18.0
Submerged	14	1248.2	1145.3	1246.0	1308.8	378.3	16.1
Submerged	15	1568.2	1439.0	1571.1	1651.8	445.5	15.1
Submerged	16	1689.2	1550.0	1698.4	1784.2	459.1	14.4
Submerged	17	1816.3	1666.6	1810.2	1911.0	482.3	14.2
Submerged	18	1312.8	1204.6	1308.7	1382.7	374.3	15.1
Submerged	19	1786.4	1639.2	1772.1	1921.0	304.6	9.0
Submerged	20	1707.8	1567.1	1772.8	1836.7	309.1	9.6
Submerged	21	1474.9	1353.4	1460.3	1586.0	242.9	8.7
Submerged	22	1434.3	1316.1	1423.3	1542.5	236.6	8.7
Submerged	23	1740.0	1596.6	1755.2	1842.1	447.4	13.7
Submerged	24	1285.2	1179.3	1282.3	1345.7	375.2	15.6
Submerged	25	1615.8	1482.6	1622.0	1707.6	386.3	12.7
Submerged	26	1740.0	1596.6	1755.2	1842.1	447.4	13.7
Submerged	27	1872.3	1718.0	1870.1	1978.2	477.1	13.6
Submerged	28	1349.2	1238.0	1350.4	1424.6	370.5	14.6

Table 12. Minimum allowable capacity (e.g. minimum breaking strength) of major structural components in extreme storm conditions with all lines intact. Recommended safety factors are included. When purchasing ropes, the breaking strength must equal or exceed the requirements shown below. The definition of minimum breaking strength of selected ropes must include reductions in strength due to knots or splicing. US Customary Units

	Case	Mooring Tension Rope [kpf]	Mooring Tension Chain [kpf]	Bridle Tension [kpf]	Anchor Capacity Horizontal [kpf]	Anchor Capacity Vertical [kpf]	Anchor Uplift [deg]
Surfaced	1	0.7	0.8	0.4	0.4	0	0
Surfaced	2	1.3	1.5	0.8	0.9	0	0
Surfaced	3	14.9	16.2	15.8	15.7	4.1	14.7
Surfaced	4	62.3	67.9	61.8	66.9	38.9	30.2
Surfaced	5	152.0	165.6	133.5	168.6	66.3	21.5
Surfaced	6	113.1	123.3	90.6	123.3	53.2	23.3
Surfaced	7	147.2	160.5	148.2	162.8	65.9	22.0
Surfaced	8	116.4	126.9	107.3	126.8	57.2	24.3
Submerged	1	2.5	2.3	2.3	1.8	0	0
Submerged	2	3.0	2.8	2.5	2.1	0	0
Submerged	3	14.8	13.6	20.6	14.7	4.6	17.3
Submerged	4	50.5	46.3	56.5	48.9	27.5	29.3
Submerged	5	113.4	104.0	102.3	115.6	45.4	21.4
Submerged	6	86.8	79.6	77.1	87.6	32.8	20.5
Submerged	7	106.4	97.7	97.2	108.1	46.9	23.5
Submerged	8	80.1	73.5	70.9	75.5	31.6	22.7
Submerged	9	387.0	355.1	399.8	416.0	69.3	9.5
Submerged	10	386.0	354.2	382.3	414.9	69.6	9.5
Submerged	11	327.2	300.2	324.5	351.8	54.5	8.8
Submerged	12	320.7	294.3	318.1	344.8	53.1	8.8
Submerged	13	278.4	255.4	278.1	291.8	94.7	18.0
Submerged	14	283.7	260.3	283.2	297.5	86.0	16.1
Submerged	15	356.4	327.0	357.1	375.4	101.3	15.1
Submerged	16	383.9	352.3	386.0	405.5	104.3	14.4
Submerged	17	412.8	378.8	411.4	434.3	109.6	14.2
Submerged	18	298.4	273.8	297.4	314.2	85.1	15.1
Submerged	19	406.0	372.5	402.8	436.6	69.2	9.0
Submerged	20	388.1	356.2	402.9	417.4	70.3	9.6
Submerged	21	335.2	307.6	331.9	360.5	55.2	8.7
Submerged	22	326.0	299.1	323.5	350.6	53.8	8.7
Submerged	23	395.5	362.9	398.9	418.7	101.7	13.7
Submerged	24	292.1	268.0	291.4	305.8	85.3	15.6
Submerged	25	367.2	337.0	368.6	388.1	87.8	12.7
Submerged	26	395.5	362.9	398.9	418.7	101.7	13.7
Submerged	27	425.5	390.4	425.0	449.6	108.4	13.6
Submerged	28	306.6	281.4	306.9	323.8	84.2	14.6

Table 13. Minimum allowable capacity (e.g. minimum breaking strength) of major structural components in extreme storm conditions with one line broken. Recommended safety factors are included. When purchasing ropes, the breaking strength must equal or exceed the requirements shown below. The definition of minimum breaking strength of selected ropes must include reductions in strength due to knots or splicing. SI Units

		Mooring Tension		Bridle	Anchor Capacity		Anchor
		Rope	Chain	Tension	Horizontal	Vertical	Uplift
	Case	[kN]	[kN]	[kN]	[kN]	[kN]	[deg]
Surfaced	1	2.3	2.6	1.4	1.9	0	0
Surfaced	2	4.4	5.0	2.8	3.9	0	0
Surfaced	3	29.5	33.8	43.8	26.0	7.5	16.1
Surfaced	4	145.8	166.8	177.3	142.6	89.9	32.2
Surfaced	5	300.4	343.6	311.4	328.8	144.8	23.8
Surfaced	6	420.3	480.9	445.0	469.0	194.2	22.5
Surfaced	7	297.0	339.7	321.2	325.5	149.4	24.7
Surfaced	8	423.1	484.1	454.7	470.3	198.6	22.9
Submerged	1	10.8	9.4	10.4	7.8	0	0
Submerged	2	13.6	11.9	12.5	9.5	0	0
Submerged	3	47.3	41.3	47.7	39.8	14.7	20.3
Submerged	4	162.1	141.7	158.5	142.4	85.3	30.9
Submerged	5	282.3	246.8	261.2	271.4	114.8	22.9
Submerged	6	385.7	337.2	358.3	380.6	142.7	20.6
Submerged	7	285.0	249.1	261.5	269.1	119.1	23.9
Submerged	8	388.0	339.2	361.5	380.8	147.2	21.1
Submerged	9	1224.7	1070.5	1216.6	1252.6	195.8	8.9
Submerged	10	1227.0	1072.5	1218.8	1254.5	196.1	8.9
Submerged	11	1461.9	1277.9	1444.1	1501.2	223.2	8.5
Submerged	12	1460.4	1276.6	1443.3	1499.7	223.9	8.5
Submerged	13	884.7	773.3	872.5	861.5	252.6	16.3
Submerged	14	859.3	751.1	840.8	858.1	249.3	16.2
Submerged	15	826.1	722.1	794.7	808.8	243.9	16.8
Submerged	16	783.4	684.8	766.4	784.1	246.3	17.4
Submerged	17	711.9	622.3	718.6	698.3	231.8	18.4
Submerged	18	960.1	839.2	989.1	1004.1	299.2	16.6
Submerged	19	1239.9	1083.9	1231.6	1268.4	199.2	8.9
Submerged	20	1242.1	1085.8	1234.2	1270.9	199.2	8.9
Submerged	21	1469.1	1284.1	1452.4	1508.5	223.5	8.4
Submerged	22	1466.8	1282.2	1450.4	1506.1	224.2	8.5
Submerged	23	793.6	693.7	777.4	797.3	241.7	16.9
Submerged	24	891.8	779.5	864.6	893.7	248.4	15.5
Submerged	25	835.8	730.6	821.8	838.9	241.7	16.1
Submerged	26	783.3	684.7	765.8	787.3	228.2	16.2
Submerged	27	948.5	829.1	930.9	939.9	287.2	17.0
Submerged	28	980.8	857.4	999.6	985.9	277.9	15.7

Table 14. Minimum allowable capacity (e.g. minimum breaking strength) of major structural components in extreme storm conditions with one line broken. Recommended safety factors are included. When purchasing ropes, the breaking strength must equal or exceed the requirements shown below. The definition of minimum breaking strength of selected ropes must include reductions in strength due to knots or splicing. US Customary Units

	Case	Mooring Tension Rope [kpf]	Mooring Tension Chain [kpf]	Bridle Tension [kpf]	Anchor Capacity Horizontal [kpf]	Anchor Capacity Vertical [kpf]	Anchor Uplift [deg]
Surfaced	1	0.5	0.6	0.3	0.4	0	0
Surfaced	2	1.0	1.1	0.6	0.9	0	0
Surfaced	3	6.7	7.7	9.9	5.9	1.7	16.1
Surfaced	4	33.1	37.9	40.3	32.4	20.4	32.2
Surfaced	5	68.3	78.1	70.8	74.7	32.9	23.8
Surfaced	6	95.5	109.3	101.1	106.6	44.1	22.5
Surfaced	7	67.5	77.2	73.0	74.0	34.0	24.7
Surfaced	8	96.2	110.0	103.3	106.9	45.1	22.9
Submerged	1	2.4	2.1	2.4	1.8	0	0
Submerged	2	3.1	2.7	2.8	2.2	0	0
Submerged	3	10.7	9.4	10.8	9.0	3.3	20.3
Submerged	4	36.8	32.2	36.0	32.4	19.4	30.9
Submerged	5	64.2	56.1	59.4	61.7	26.1	22.9
Submerged	6	87.7	76.6	81.4	86.5	32.4	20.6
Submerged	7	64.8	56.6	59.4	61.2	27.1	23.9
Submerged	8	88.2	77.1	82.2	86.5	33.5	21.1
Submerged	9	278.3	243.3	276.5	284.7	44.5	8.9
Submerged	10	278.9	243.8	277.0	285.1	44.6	8.9
Submerged	11	332.2	290.4	328.2	341.2	50.7	8.5
Submerged	12	331.9	290.1	328.0	340.8	50.9	8.5
Submerged	13	201.1	175.8	198.3	195.8	57.4	16.3
Submerged	14	195.3	170.7	191.1	195.0	56.7	16.2
Submerged	15	187.8	164.1	180.6	183.8	55.4	16.8
Submerged	16	178.1	155.6	174.2	178.2	56.0	17.4
Submerged	17	161.8	141.4	163.3	158.7	52.7	18.4
Submerged	18	218.2	190.7	224.8	228.2	68.0	16.6
Submerged	19	281.8	246.3	279.9	288.3	45.3	8.9
Submerged	20	282.3	246.8	280.5	288.8	45.3	8.9
Submerged	21	333.9	291.8	330.1	342.9	50.8	8.4
Submerged	22	333.4	291.4	329.6	342.3	51.0	8.5
Submerged	23	180.4	157.7	176.7	181.2	54.9	16.9
Submerged	24	202.7	177.2	196.5	203.1	56.5	15.5
Submerged	25	190.0	166.0	186.8	190.7	54.9	16.1
Submerged	26	178.0	155.6	174.1	178.9	51.9	16.2
Submerged	27	215.6	188.4	211.6	213.6	65.3	17.0
Submerged	28	222.9	194.9	227.2	224.1	63.2	15.7

Table 15. Summary: Minimum allowable capacity (e.g. minimum breaking strength) of major structural components in extreme storm conditions with one line broken. Recommended safety factors are included. When purchasing ropes, the breaking strength must equal or exceed the requirements shown below. The definition of minimum breaking strength of selected ropes must include reductions in strength due to knots or splicing. SI Units

	Line Scenario	Anchor-chain Capacity [kN]	Anchor-rope Capacity [kN]	Bridle-line Capacity [kN]	Anchor Horizontal Capacity [kN]	Anchor Vertical Capacity [kN]	Uplift Angle [deg]
Surfaced	Intact	669	729	652	742	292	21.5
	Broken	423	484	455	470	199	22.9
Submerged	Intact	1,718	1,872	1,870	1,978	482	13.7
	Broken	1,284	1,469	1,452	1,509	299	11.2

Table 16. Summary: Minimum allowable capacity (e.g. minimum breaking strength) of major structural components in extreme storm conditions with one line broken. Recommended safety factors are included. When purchasing ropes, the breaking strength must equal or exceed the requirements shown below. The definition of minimum breaking strength of selected ropes must include reductions in strength due to knots or splicing. US Customary Units

	Line Scenario	Anchor-chain Capacity [kip]	Anchor-rope Capacity [kip]	Bridle-line Capacity [kip]	Anchor Horizontal Capacity [kip]	Anchor Vertical Capacity [kip]	Uplift Angle [deg]
Surfaced	Intact	152	166	148	169	66	21.5
	Broken	96	110	103	107	45	22.9
Submerged	Intact	390	426	425	450	110	13.7
	Broken	292	334	330	343	68	11.2

5.1.3 Consideration of Vortex Induced Oscillations

Steady fluid flow past a structure (due to current, tides, etc.) may, under the right conditions, induce unsteady oscillations of the structure, a phenomenon known as Vortex Induced Vibration (VIV). While the physical conditions that create VIV are complex, VIV can occur when the frequency at which vortices are shed (shedding frequency) from a structure match the natural frequency of motion of that structure.

Motions due to VIV may contribute to fatigue of structures and should be considered in design load calculations if they occur at high current speeds (when other loads and motions are also severe). Because VIV is difficult to predict analytically, Kelson used a combination of simplified numerical modeling and standards-based analysis (DNV, 2010) to predict the conditions at which it may occur. Standards-based analysis predicts that the peak VIV on the system will be induced at a current speed of 0.067 m/s (0.13 kts). This is confirmed by the simplified numerical model. Using an empirically calibrated wake oscillator model, Kelson simulated a simplified model of the cage, moorings, and bridle under several current speeds. This model predicted that the cage spars will experience VIV at current speeds between 0.067 m/s (0.13 kts) and 0.134 m/s (0.26 kts), with the peak response at 0.067 m/s. See Table 17.

Table 17: Oscillation frequency and amplitude predicted by the numerical wake oscillator model at three current speeds.

Current Speed [m/s]	VIV Frequency [Hz]	VIV Oscillation Amplitude [m]
0.067	0.016	0.3
0.101	0.021	0.3
0.134	0.026	0.1

The estimated current speeds for maximum VIV are much lower than the 10-year or 50-year return periods, and the estimated oscillation amplitudes are small and associated with large oscillation periods (approximately 60 seconds). Therefore, Kelson does not anticipate that VIV will contribute to the maximum loads on the structure. However, Kelson recommends that the operators make note of VIV if it is observed, as it may contribute fatigue damage to the cage.

5.1.4 Extreme Displacement of Cage and Downstream Corner Float Buoys

The maximum horizontal displacements of the cage and downstream corner float buoys, as well as the maximum submergence of the corner floats, are summarized in Table 18 and Table 19 relative to their equilibrium positions. The maximum horizontal displacements occur in upstream or side buoys in the shallow-water conditions. The maximum submergences occur in upstream buoys in the deep-water conditions.

Contact forces between the cage structure and the seabed were checked in all simulations. While this is difficult to quantify without detailed geotechnical data, in each simulation case the ratio between contact force and mooring load was checked (assuming a seabed stiffness of $1 \times 10^6 N/m/m^2$). The contact force never exceeded 0.6% of the peak mooring load in a simulation. This minimal contact force is deemed acceptable by Manna Fish Farms.

Table 18: Displacements of cage and corner float buoys. Horizontal displacements are relative to calm water equilibrium positions. SI Units.

	Surfaced [m]	Submerged [m]
Cage Horizontal Displacement		
Intact	30	48
Broken	43	65
Corner Float Horizontal Displacement		
Intact	40	46
Broken	68	79
Corner Float Max Submergence		
Intact	13	37
Broken	16	38

Table 19: Displacements of cage and corner float buoys. Horizontal displacements are relative to calm water equilibrium positions. US Customary Units.

	Surfaced [ft]	Submerged [ft]
Cage Horizontal Displacement		
Intact	97	158
Broken	140	215
Corner Float Horizontal Displacement		
Intact	130	150
Broken	224	259
Corner Float Max Submergence		
Intact	41	121
Broken	51	124

5.1.5 Anchor Uplift

To achieve the dual design objectives of limiting anchor scope to 1:1 and minimizing seabed contact forces, the present design will subject the embedment anchors to uplift loads. According to several design standards including ABS (ABS, 2013) and API (API, 2005), this is acceptable if done carefully. API recommends the following guidelines:

> Significant evidence is present to support the allowance of vertical loads on some drag embedment anchors. Following are the guidelines for drag embedment anchors subject to vertical loads.
> 1. Vertical loads are applied to anchors under extreme environment only. Drag embedment anchors should not be subjected to vertical loads under normal operating environments.
> 2. It is applicable only to certain high efficiency anchors for which sufficient research has been conducted and much field experience has been gained.
> 3. The anchors are deployed in soft clay where deep penetration is expected. This may exclude certain operations with mobile moorings where the soil conditions have not been thoroughly investigated or the anchor test load is insufficient to ensure deep penetration.
> 4. The maximum line angle at the mud line (including the effect of wave and low frequency vessel motions) should be less than 20° under the maximum design environment for the intact and damaged condition. This angle should be zero at the early stage of test loading to ensure anchor penetration. Furthermore, the holding capacity should be reduced by a factor R, which is a function of the angle at the mudline and takes into account the reduced friction due to shorter embedded line length.

Furthermore, the ABS Guide for Position Mooring Systems (ABS, 2018) states the following (section 7.9.4; emphasis added):

> For drag anchors, the mooring line length should in general be sufficient to prevent anchor uplift under the design environmental condition. This requirement is especially important for anchors in sand and hard soil where anchor penetration is shallow. For soft clay conditions, a small angle for the damaged case with one broken line may be considered by ABS on a case-by-case basis. *Uplift of drag anchors may be permitted if it can be demonstrated that the anchor has sufficient vertical resistance for the soil condition under consideration.*

Because these guidelines recommend uplift be limited to soft clay soils or that the uplift capacity of the anchors be demonstrated, Kelson makes the following additional recommendations:

1. Anchors be deeply embedded to achieve maximum vertical holding strength. This embedment should be done to the full design load.
2. After completion of anchor installation, anchors be proof tested with a load and uplift angle matching the design conditions. Table 20 recommends two proof load tests which represent the peak vertical load and uplift angle in the submerged conditions.

Table 20: Suggested anchor proof load capacities.

	Horizontal Load [kN]	Vertical Load [kN]	Uplift Angle [deg]
Proof Test 1	1,911	482	14
Proof Test 2	215	121	29

3. The cage be submerged in the 99% sea condition (Current = 0.51 m/s, H_s = 1.8 m, T_p = 4.5 s) and all conditions more severe.
4. High-efficiency embedment anchors be used.

6 Conclusion

To mitigate the risk of structural failure in extreme storms, key components of the mooring system must meet or exceed the required structural capacities reported in Table 11 – Table 14. This corresponds to:

- Mooring rope size ranging from 51 mm (2”) to 120 mm (4-3/4”) depending on material type used.
- Bridle rope size ranging from 51 mm (2”) to 120 mm (4-3/4”) depending on material type used.
- Studless anchor chain with a wire diameter of 38.1 mm (1-1/2”). The grade must be selected to ensure the structural capacities are met.
- Anchor weight of 3,000 kg. Because uplift occurs at the anchor, a high capacity embedment anchor must be used, and sufficient anchor penetration must be ensured during installation.

The Corner Float buoys must have a net buoyancy of approximately 5,000 kg (11,000 lbs) to prevent severe seafloor contact in the most extreme storms. An example commercial buoy that meets this criterion is Ocean Guard™ MB-50. A “spar” shaped buoy with an aspect ratio of 5:1 ($Length/Diameter$) would be at least 5.8 m (19.0 ft) tall with an outer diameter of 1.2 m (3.8 ft), assuming a net buoyancy of 5,000 kg.

No special accommodations to mitigate animal entanglement were considered in this analysis, since the size and diameters of the ropes and buoys are large – similar to those used for traditional large ocean structures.

The proposed mooring system includes lines at the surface. To mitigate navigational risks, vessels should be warned against traversing the farm.

7 References

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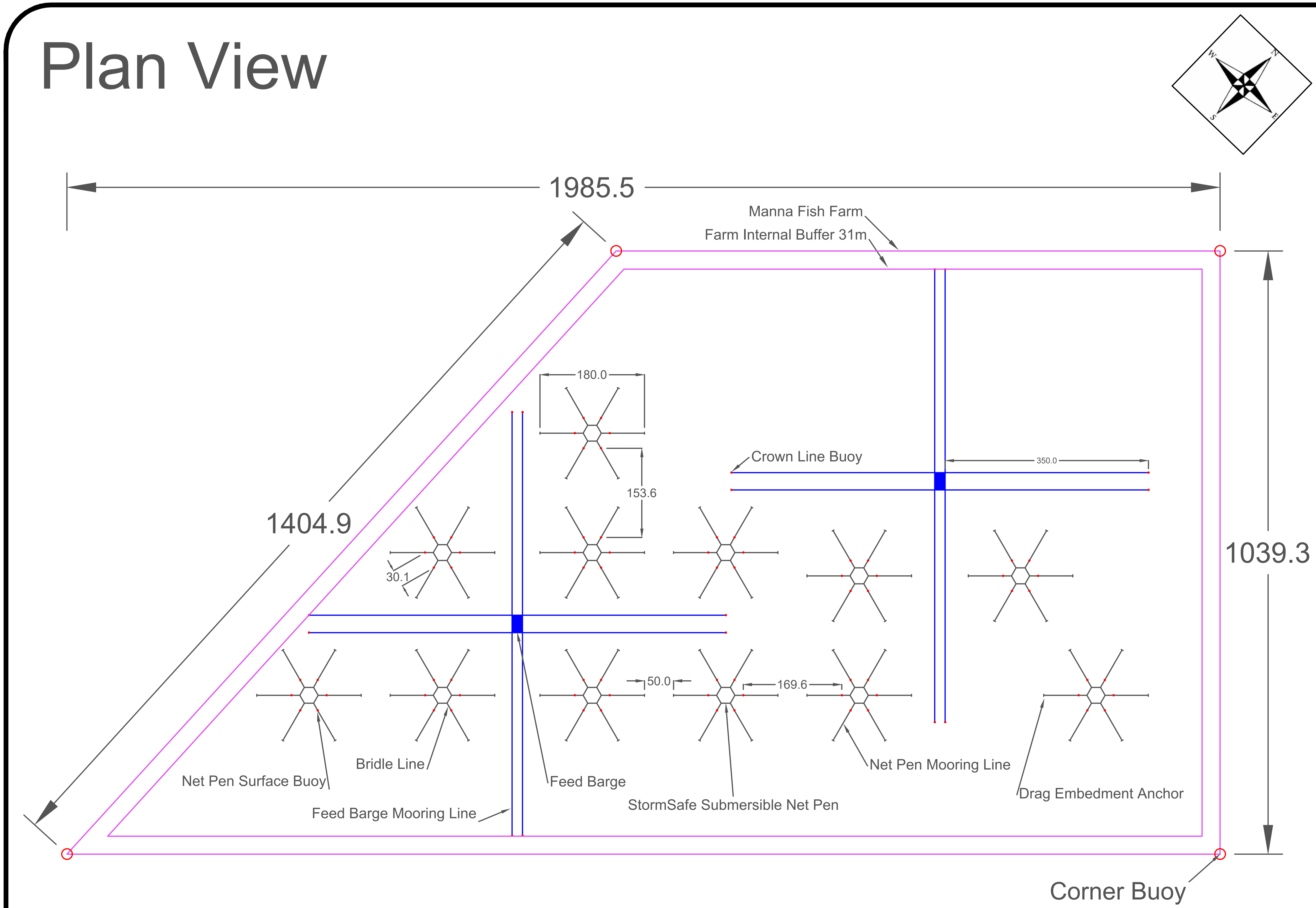
Appendix J:

Farm Design

Plan View



General Notes

- Full 12 net pen deployment
- 1.572 km² (388.5 acre) farm footprint

- StormSafe® Submersible Net Pens
  - Individually moored with 1 drag embedment anchor per net pen corner
  - 1.2:1 mooring line scope
  - 6 surface buoys per net pen

- 30x18m Feed Barges
  - 2 barges
  - Assumes mooring line scope of 7:1
  - Assumes 8 drag embedment anchors per barge
  - Crown line with small surface float above each barge anchor

Units are Meters

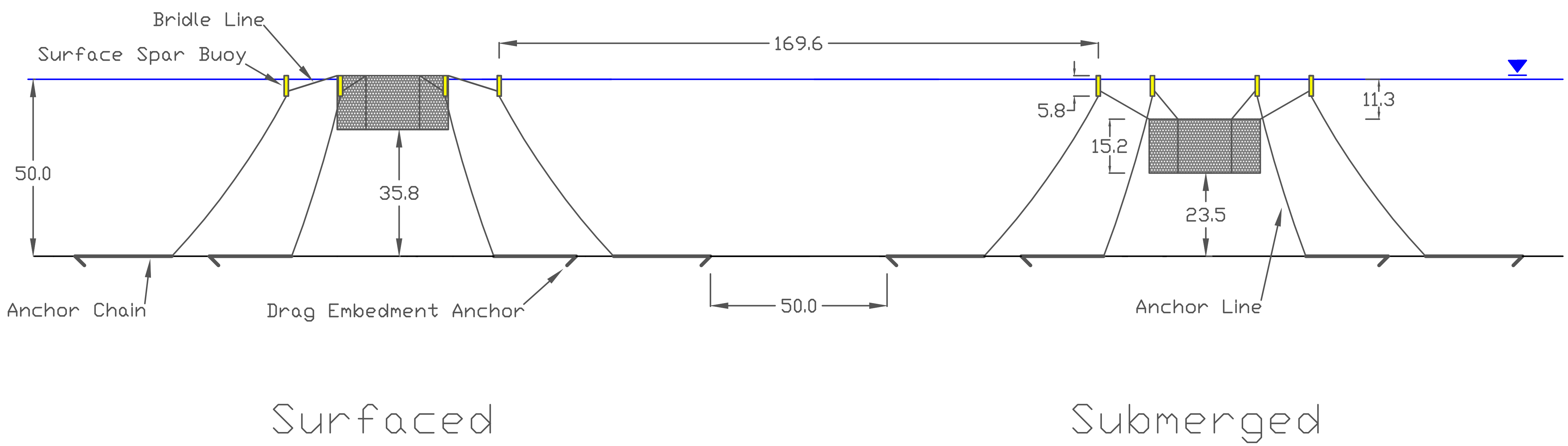
No.1	Drawn By: ZD	3/30/22

Manna Fish Farms Inc.

Manna Fish Farms - Gulf of Mexico

Project Manna GOM	Sheet 1 of 2
Date 3/30/22	
Scale 1:6.834	

Profile View



General Notes

- StormSafe® Submersible Net Pens
  - Individually moored with 1 drag embedment anchor per net pen corner
  - 1.2:1 mooring line scope
  - 6 surface buoys per net pen
  - Surface and submerged configurations shown
  - Only 4 of 6 mooring lines are visible here for each net pen
  - Buoy dimensions and net pen depth are subject to change

Units are Meters

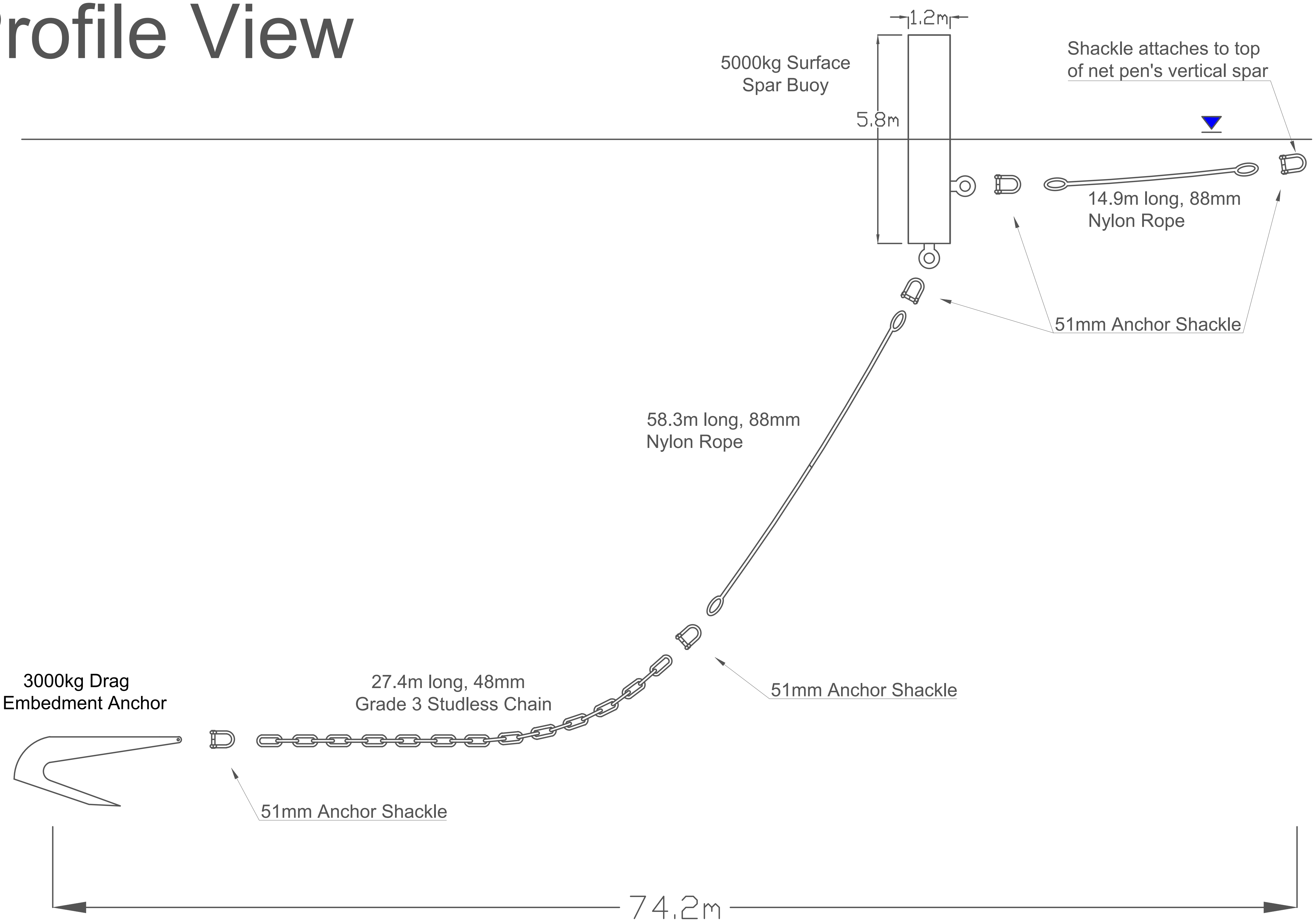
No.1	Drawn By: ZD	3/30/22

Manna Fish Farms Inc.

Manna Fish Farms - Gulf of Mexico

Project Manna GOM	Sheet 2 of 2
Date 3/30/22	
Scale 1:1.423	

Profile View



NOT TO SCALE

General Notes

- StormSafe® Mooring Leg (6 legs per net pen system)
- Line lengths and anchor to net pen distance are based on 1.2:1 mooring line scope and 50m depth
- All component specifications reflect currently commerically available products and are subject to change due to technological advancements over time

SI Units

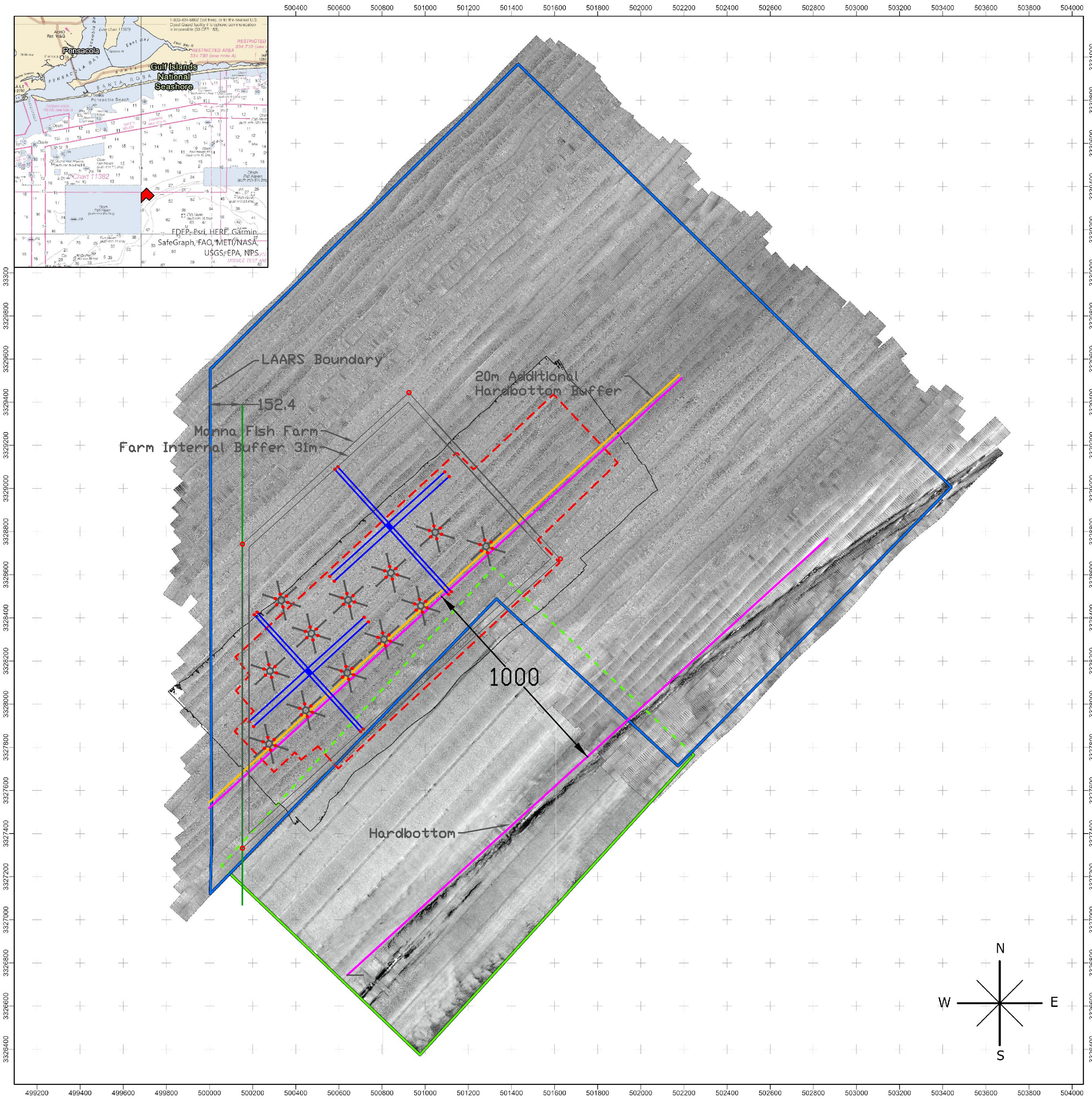
No.1	Drawn By: ZD	3/30/22

Manna Fish Farms Inc.

Manna Fish Farms - Gulf of Mexico

Project Manna GOM	Sheet 1 of 1
Date 3/30/22	
Scale Not to Scale	

DRAFT



Manna Fish Farms Offshore Aquaculture Site

Gulf of Mexico

Baseline Environmental Surveys: 2019-2020

SIDE SCAN SONAR DATA MAP COMPILATION

LEGEND

- Outline of 2020 Survey Area (DEA) (100% Side Scan Coverage)
- Outline of 2020 Survey Area (DEA) (100% Multibeam Bathymetry Coverage)
- Outline of 2019 Survey Area (USM) (100% Side Scan and Multibeam Bathymetry Coverage)
- Outline of Proposed Aquaculture Sites

NOTES

1. 2020 Baseline Environmental Survey conducted 8-10 December 2020 by the Marine Services Division of David Evans and Associates, Inc.

2. 2019 Baseline Environmental Survey conducted 21 and 28 May 2019 by the University of Southern Mississippi.

2. Coordinates are in meters relative to North American Datum of 1983 (NAD83), Universal Transverse Mercator (UTM) Zone 16 North.

3. Overview map is National Oceanic and Atmospheric Administration (NOAA) chart 11360 with depths in fathoms.

0 750 1,500 2,250 3,000

Distance in US Feet

0 250 500 750 1,000

Distance in Meters

Map Scale 1:12,000

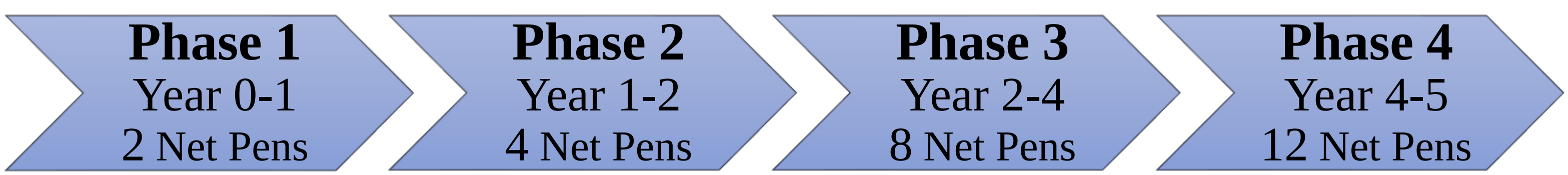
DAVID EVANS AND ASSOCIATES INC.

14231 Seaway Road, Suite 4002
Gulfport, MS 39503
www.deainc.com

Manna GOM Primary Gear List

Equipment	Associated Gear	Dimensions of Gear	Quantity (per net pen system)
StormSafe® Submersible Net Pen		31.4 m diameter hexagon, 15.2 m height, 9000 m^3 volume	1
	Drag Embedment Anchors	3000 kg	6
	Anchor Chains	27.4 m length, 48 mm (1.9”) Grade 3 studless chain	6
	Anchor Lines	58.3 m length, 88 mm (3.5”) diameter, nylon rope	6
	Bridle Lines	14.9 m length, 88 mm (3.5”) diameter, nylon rope	6
	Surface Buoys	Spar shaped, 5.8 m tall, 1.2 m diameter 5000 kg net buoyancy	6
Equipment	**Associated Gear**	**Dimensions of Gear**	**Quantity (per farm)**
Feed Barge		31.5 x 12.5 m 450 metric ton capacity	2
	Drag Embedment Anchors	750 kg	16
	Anchor Lines	354.3 m length, 32 mm (1.26”) Grade 3 studless chain	16
	Crown Lines	55.3 m length, 18 mm (0.71”) Grade 2 studless chain	16
	Crown Line Buoys	Spherical, 1.02 m diameter 448.6 kg net buoyancy	16

*Line lengths and barge dimensions are approximate; all gear specifications are subject to change due to technological advancements over time and feed barge gear specifications are additionally subject to change due to feed barge manufacturer input



Appendix K:

Fish Health Management Plan

Manna Fish Farms

GOM Offshore Farm and Land-Based Nursery

Fish Health Management Plan

This plan has been reviewed and approved by:

Name:

Signature:

Date:

Table of Contents

1 Introduction

Manna Fish Farms operates on the basis that fish health is directly related to farm management, husbandry practices, and water quality.

The goal of this Fish Health Management Plan is to minimize the risks to fish health as a result of operator practices and ensure that the optimum standards of bio-security controls are observed in the hatchery and on the farm at all times.

It is intended that these guidelines and associated Biosecurity Policy and practices be reviewed, assessed and amended on an ongoing basis.

Veterinary services to Manna Fish Farms are provided by;

Center For Aquatic Animal Research and Management
Stephen Frattini DVM
29 Lake Ellis Road
Wingdale, NY 12504
CFAARM.org

1.1 Objective

The objective of this Fish Health Management Plan (FHMP) is to optimize good health conditions for cultured fish at Manna Fish Farms (Manna) at both land based and offshore facilities located in Florida (FL). This plan recognizes that disease outbreaks in fish farms are influenced by interactions between the fish, the aquatic environment, and potential pathogens. The FHMP seeks to standardize efforts to prevent disease where possible and treat where necessary.

This FHMP is specific to Manna's operations located in FL and serves to specify the responsibilities and capabilities of management and operational staff. This FHMP puts in place the necessary mitigation measures for specific identified risks, such as disease outbreaks. The FHMP provides defined mechanisms to improve production by appropriate record keeping, staff training and for the development and implementation of best practices in the culture of fish at the facility.

In summary, this FHMP addresses the following:

Potential risks in the land-based nursery and offshore growout areas and appropriate mitigation
The exclusion of pathogens through the use of best practices on-site
The management of disease
The improvement and maintenance of fish health and welfare

1.2 Target Audience

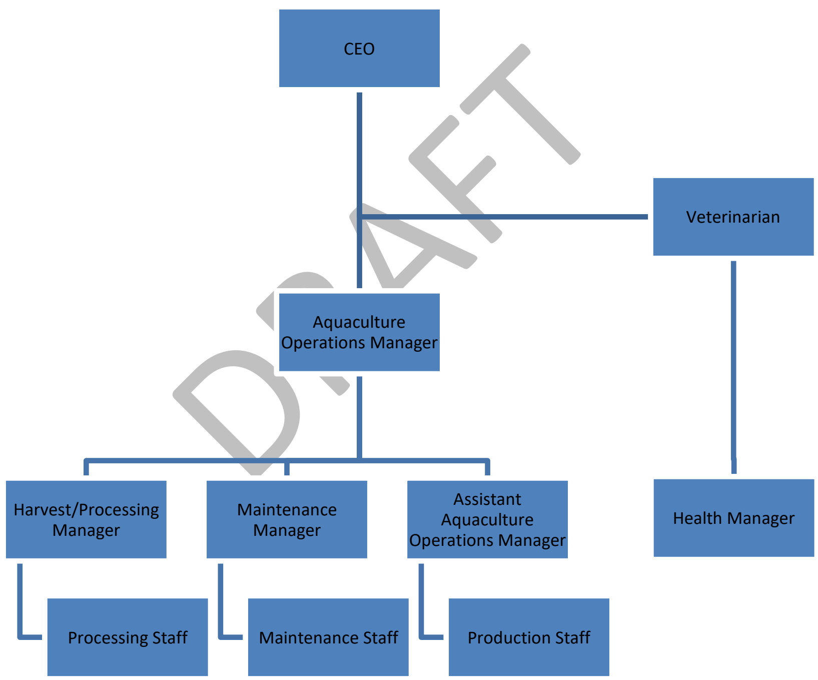
This plan is intended for use by Management and other staff who have been approved to make decisions concerning fish health management and production targets. All operational staff should be familiar with its overall objectives and the part they play in contributing towards good fish health management.

1.3 Annual Review

This document will be subject to an annual review by Management in consultation with the veterinary provider. Standard Operating Procedures (SOPs) may be reviewed and amended on a more regular basis and as needed. The FHMP will be a dynamic document which is designed to work in conjunction with the production and nursery/growout SOPs. Both documents are subject to a process of continual improvements based on issues and solutions encountered daily. If an SOP and the FHMP contradict each other the FHMP shall be followed and the error will be brought to Management's attention immediately. Many topics covered in this FHMP are discussed in further detail in the SOPs.

2 Organizational Structure

Below is the Manna organizational structure as it pertains to the FHMP and production operations. *(Proposed)*



3 Personnel Duties and Responsibilities

3.1 Management

The management team are responsible for defining the policies regarding fish health management and biosecurity of the site. Management also provide the necessary equipment and training to ensure that the highest culture standards are maintained by all staff. Management is also responsible for all record keeping, biosecurity measures, SOPs, and administration of any treatments including record keeping.

3.2 Veterinarian

The veterinarian is responsible for fish health and disease management for Manna. Fish health management includes, but is not limited to, providing decisions and options to be considered by Management for major fish health and biosecurity issues such as quarantine, disease outbreaks and disease prevention. The veterinarian is co-responsible with Management for identifying potential and actual pathogen or disease exposure risk factors (See **Appendix III** for a list of potential pathogens) and recommending appropriate mitigation measures to minimize their effects on fish health.

3.3 Production Managers/Supervisors/ Staff

Production Managers and Staff are responsible for ensuring that the day to day operations of the site are carried out using best practice as directed by Management and the SOPs.

Other staff may be directed to assist in production operations. These staff will be properly trained in the appropriate task and shall not undertake any task, or enter any area they have not been specifically trained and instructed to do so.

3.3.1 Task Supervisors

There are specific supervisors/staff for certain tasks as prescribed by Management. They are responsible for ensuring best practice is observed in relation to their specific task. They also ensure that relevant data are delivered to Management at the end of the day.

3.4 Job descriptions

A detailed job description for each role is prescribed by Management; however, it is also the duty of all staff to identify if they have a potential water quality or fish health issue and to bring any concerns immediately to the attention of Management. They shall also be fully trained in the biosecurity measures on site to ensure that all potential fish health issues are addressed.

4 Farm Operations

4.1 Overview

The Farm Operations section describes the daily operations at Manna and how these have an impact on the overall fish health and fish welfare.

The personnel responsible for each specific activity will have the appropriate training, skills and background knowledge necessary to carry out the task at hand.

Management will remain aware of the effects of subclinical disease issues on stock growth. Regular monitoring and recording of all environmental parameters, feeding, mortalities, and actual and predicted stocking densities help to ensure that optimum culture conditions are maintained.

Monitoring and optimal husbandry techniques help to ensure that fish health is maintained at the highest level and that the nursery and farm are kept as disease free as possible.

4.2 Standard Operating Procedures (SOPs)

SOPs are employed as a method to convey to personnel the best practice for the particular task at hand. They are specific, and created based on the equipment available to operators for the task concerned.

SOPs are created by Management in order to maintain fish health at all times. Management must ensure staff are trained on all relevant SOPs and encourage them to be aware of potential or actual fish health issues regardless of the task they are carrying out.

A template for SOPs can be found in **Appendix II**. Detailed SOPs can be found in the SOP Manual maintained as to be accessible at both land-based and offshore sites. All personnel must be made aware of the locations and must sign to indicate that they have read and understand all relevant SOPs. On-site training supplements the SOPs and Management will accept all relevant input received from staff.

5 General Principles of Fish Health Management

5.1 Keeping Fish Healthy

Maintaining healthy fish populations is crucial to preserving the overall health status of the site. This is best carried out by reducing fish stress levels to a minimum at every stage of production. At each of these stages it is imperative that all staff that have direct contact with the fish are fully aware of the pertinent SOP's and have been trained as such.

Operators must be trained to monitor for signs of stress and potential disease issues with fish stocks. Fish may display both physical and behavioural changes which can indicate to operators that there is an issue with a particular group of fish. Any changes in the normal appearance and behaviour of the fish must be relayed as soon as possible to Management for further investigation.

> **Physical Changes** – skin darkening or reddening, bloating, trailing fecal casts, scale loss, missing or nipped fins, fungal or ulcerative lesions, visible ectoparasites, gasping, obvious eye injuries, and protrusions
>
> **Behavioural changes** – changes in swimming behaviour, flashing, lethargy, abnormal feeding response, and gasping at the surface

Fish must be kept at reasonable densities as determined by size, number, and tank and pen volume. Acknowledgement of changes in appearance and behaviour such as those listed above are a precursor to determining a potential fish health issue and will allow management to deal with it immediately.

The second most important aspect to fish health management is a rigorous biosecurity protocol and this will be discussed later in this section.

5.1.1 Water Quality

A healthy culture environment is imperative to fish health. Water that is not of optimum quality on a prolonged basis will lead to stress which will ultimately lead to a mortality event or disease outbreak.

Manna uses water from a well located on-site at the University of Southern Mississippi's Thad Cochran Marine Aquaculture Center (TCMAC) in Ocean Springs, MS that is brined using an artificial salt, Crystal Seas-Bioassay formula, manufactured by Marine Enterprises International LLC located in Baltimore MD. Offshore operations rely on the naturally occurring water quality of the site. Water quality monitoring and interpretation of results is crucial to maintaining healthy fish stocks on site. Specific parameters should be measured continuously, or alternatively as point-in-time, as determined by Management. Continuous monitoring is carried out by automated systems at both the hatchery and offshore facilities.

The basic measurements of oxygen saturation, temperature, and water levels are available on display continuously. Each of these parameters has specific set points and alarms which each operator is trained to either directly respond to and/or contact the supervisors to resolve the problem. Other water quality parameters are measured using handheld meters by specific trained personnel and the results are interpreted and recorded by management.

Because Manna uses recirculating aquaculture systems (RAS) in the nursery we have control over all of the critical life support parameters to keep the fish healthy. In the event of a catastrophic failure of a life support system, standby pumps (*in-situ)*, additional oxygenation, and backup electrical generation systems are available and implemented. Senior staff members are aware of the procedures involved during these crucial incidents and are able to initiate emergency measures as needed.

RAS culture relies fundamentally on the “health” of the bacterial community comprising the bio-filter. The bio-filter consists of 2 different populations of nitrifying bacteria which convert the ammonia excreted by the fish first to nitrites and then to nitrates. Bio-filters must be monitored daily as part of the husbandry team’s husbandry protocols. Under-performing or compromised bio-filters can induce stress and illness and if untreated, will cause catastrophic mortality.

The daily data collected from the monitoring of the system function and the chemical and physical characteristics of the water is used to assess fish welfare. As part of an overall contingency plan to cover system failure, TCMAC has built-in fail safes (generators, actuated oxygen delivery, a large inventory of sanitized artificial salt water, and redundant systems) available to mitigate issues that jeopardize the welfare, health and growth of the animals.

Manna also relies on an offshore net-pen grow-out containment system. The instrumentation deployed at the site will maintain continuous water quality monitoring, collecting data such as dissolved oxygen, temperature, pH, salinity, etc. Additionally, monitoring of the local and regional weather conditions will impact the site’s water quality and will play a pivotal role in fish health.

5.1.2 Fish Health Routine Screening Plan

The Fish Health Routine Screening Plan can be found in **Appendix IV** of this document. Fish cultured by Manna will be routinely monitored for signs of health and disease. All staff will be familiar with healthy behaviour of fish throughout their life cycle. Key activities of healthy fish can be categorized into physical, behavioral, and feeding responses.

Fish will be kept at a reasonable density for the system to support fish health and optimal growth. Changes in behaviour and physical conditions of the fish will be reported to Management. Equipment damage and malfunctions will also be reported to Management in a timely manner.

Early detection is vital to maintain good disease management. Communication between staff and Management is necessary to ensure optimal culture conditions are met to achieve targets.

The routine screening plan consists of daily, weekly, and monthly checks by staff and management on site, and third party checks performed offsite. Monitoring by third parties includes biannual fish health screenings from our veterinary provider and water quality assessments performed by an environmental testing laboratory. Checks in the routine screening plan are outlined in the table below. Refer to **Appendix IV** for a copy of the complete routine screening plan in place at Manna.

Daily	Weekly	Monthly	Biannual	As required
System component checks	System cleanliness	In-house fish health sampling	Regulatory health checks	External water quality assessments
Fish health, behavior		Veterinary health sampling		Non-routine health sampling
Water quality monitoring				
Mortality classification				

5.1.3 Record Keeping

Record keeping is essential for the long-term planning and comprehensive evaluation of fish health and production. It generates data which can indicate trends and can aid the traceability of events and their impacts. Such information is necessary to having a data-based approach to improving fish health management, and for recognition of health or production issues between and within cohorts.

Staff are instructed by Management in the proper procedures for record keeping. Staff are responsible for various record keeping throughout their day, and additionally as related to specific tasks.

It is the responsibility of Management to review these records regularly.

5.1.4 Biosecurity

Biosecurity is defined for this FHMP as the actions undertaken to prevent the introduction or spread of disease agents into or out of our facility. Biosecurity is crucial to maintaining healthy fish stocks and preventing the transference of any pathogen from one culture area or tank to another.

The basic premise of Biosecurity at Manna involves three core components.

Keeping fish healthy
Keeping pathogens out
Keeping disease from spreading

Maintaining a clean, safe work environment will reduce the possibility for spread and exposure of fish to disease agents. Pathogens may be spread unknowingly by personnel using shared gear between tanks/pens, not disinfecting between tanks/pens, and by visitors not being properly screened prior to entry.

Manna's nursery at TCMAC is a completely enclosed biosecure facility. The building is outfitted with two entrances, one at the front and a service entrance to the rear of the building. Traffic on campus and to this building is monitored and guests are screened and briefed prior to their arrival to ensure any visits or tours pose no health risk to the live animals. Entrances are furnished on the exterior with signage advising the biosecurity threat, species cultured and personnel contact information. All entrances are locked at all times. Prior to entering culture areas, guests must be accompanied by a supervisor/ manager. Once inside, the entrance is furnished with a foot bath to sanitize footwear and a hand sanitizing station that all persons are required to use. All visitors and contractors must acknowledge posted biosecurity materials before entry and sign the entrance log. Staff are required to enter and exit using their assigned access method (keys, cards, etc.) and sign the staff entry log. All these preventative measures are part of TCMAC's biosecurity SOP (Appendix X).

Manna's grow-out facility is located (23) miles offshore and is not accessible by the general public. Personnel biosecurity procedures developed for the land-based operation will be similarly followed for the offshore site as well. Security is maintained by the location and appropriate signage directing non-essential persons to avoid the area, for both legal and biosecurity purposes.

All persons are required to enter the facilities via an anteroom, which is cleaned by a designated employee regularly. Similar procedures will be implemented for offshore personnel, briefly, this includes personal and clothing cleanliness and continued hygiene.

Employees will be given clothing that they must change into after entering the anteroom. They will also receive appropriate attire (rain jacket, rain pants and approved rain boots). All staff clothing, rain gear and boots are kept in the anteroom and maintained separately for each employee. No clothing gear is permitted to be taken from the premises and no outside gear is permitted past the change room area. Staff clothing will be cleaned either at the end of their shift rotation or if they become soiled. On site washer and dryer will be used to clean uniforms.

All visitors are disinfected before entry and are only permitted in the non-production, designated viewing areas.

If any guests are taken into the production areas, they must wear boots and clothing supplied by Management before entering the facility. Hand sanitizer and foot baths must be used at all entrances where they are located.

All persons in the facility are expected to use all footbaths and hand sanitizing stations. Production employees are expected to change all footbaths and sanitizer dispensers as necessary.

Nets, buckets, brushes, etc. are to stay in the section they are allotted. No gear is moved between systems for any reason. Crowd/seine nets are designed for each particular system and must also stay in that area of the building. After use, hand nets must always be disinfected with a solution of hydrogen peroxide and allowed to dry.

Employee access methods are designed such that employees only have access to areas of the facility that they will need to be in to do their daily routine. If an employee is scheduled to do a task that they regularly do not do, a restricted access method may be issued to that employee in order to have access to the area required to complete the task.

Buckets and nets used for mortalities are marked and all employees are made aware of proper use. These items are not to be used for any purpose other than what is described in the mortality handling SOP. Additional buckets, brushes or nets may be labelled for specific uses. These items must not be used for any purpose other than what is described.

Management may require an employee to do a task that will prevent them from returning to specific production areas for the remainder of day. These tasks compromise the biosecurity of the employee and are typically done at the end of day. It is expected that the employee return the next day clean and with fresh clothing.

Under no circumstance should any unqualified employee, visitor, or contractor touch any production water, enter the biofilter area, or access the net pens without explicit permission and oversight from Management.

5.1.5 Equipment Disinfection

All received equipment will be disinfected with hydrogen peroxide before being brought into the facility.

All equipment used must be disinfected prior to and after use. Where possible specific equipment for a particular culture tank/pen must remain within that area and must not be transferred between culture tanks.

Other equipment such as graders and counters must be disinfected before new stocks of fish are put through them. Manna plans to use hydrogen peroxide for the disinfection of all non-in-water equipment at the offshore farm. SOPs with regard to the disinfection of these and other items of equipment are contained within the SOP Manual.

5.1.6 Feed Storage

Starter feeds for the nursery are located in a climate-controlled area within the main production building. All feed for the net pen growout phases will be stored either on the deck of the on-site support vessel in a climate-controlled enclosure to prevent degradation from heat and humidity, or in silos on-board the feed barges.

Feed deliveries are inspected by qualified personnel upon arrival at the nursery facility or port location and before storage in a designated feed storage area. Any issues with the delivery, e.g. damaged bags or pallets, pest residues on bags or pallets, evidence of tampering, etc. are recorded on the Incoming Feed Shipment Inspection Form and reported to Management who report these issues to the feed suppliers. Lot numbers, sizes and quantities of the feed are recorded on the Incoming Feed Shipment Inspection Form and kept by Management as part of the overall traceability program.

Manna also implements routine pest control processes on site which control and remove any rodent or other pest issues both onshore at the nursery building and offshore on the support vessels.

5.1.7 Chemical Storage

All chemicals are stored within a dedicated chemical room and the loading area of the farm for land-based operations. At the offshore farm, all chemicals are stored within a dedicated chemical room onboard either the support vessels or feed barges. Chemical lot numbers are recorded and any issues with the deliveries are reported to Management. Staff asked to use chemicals are fully trained in safe practices and are made aware of the provided Safety Data Sheets.

5.2 Animal Welfare Section (to be updated with management)

"Animal welfare means how an animal is coping with the conditions in which it lives. An animal is in a good state of welfare if (as indicated by scientific evidence) it is healthy, comfortable, well nourished, safe, able to express innate behaviour, and if it is not suffering from unpleasant states such as pain, fear and distress. Good animal welfare requires disease prevention and veterinary treatment, appropriate shelter, management, nutrition, humane handling and humane slaughter/killing. Animal welfare refers to the state of the animal; the treatment that an animal receives is covered by other terms such as animal care, animal husbandry, and humane treatment."

-World Organisation for Animal Health, Terrestrial Animal Health Code, Chapter7.1, Article 7.1.1

In order to provide fish populations with optimal culture conditions, Manna recognizes and strives to implement the following five freedoms, adapted for aquaculture by the Farmed Animal Welfare Council (2005).

Free from hunger and/or malnutrition
Free from discomfort due to adverse environmental factors

Free from disease and injury
Free from behavioural restriction (lack of space)
Free from fear and distress

At Manna we espouse these values and provide our fish with optimal culture conditions at each stage of the culture process. Both the OIE Aquatic Animal Health Code and FAO Technical Guidelines for Responsible Fisheries 5, Supplement 2: Health Management for the Responsible Movement of Live Aquatic Animals were used to assemble this FHMP and the SOPs. Further information regarding these resources can be found in **Appendix I**.

All nursery fish remain on the same property and have low risk of cross contamination with the outside. All grow-out fish are housed in a method that strives for the exclusion of all possible wild or human vectors of disease. Manna follows all applicable national and state laws governing the safe and responsible growing of aquacultured fish species. Manna does monthly in-house disease screening as well as bi-annual site visits from our veterinary provider. In the event of an outbreak of a disease, we have steps in place as mentioned in this FHMP for diagnosing the disease, isolation of the fish, handling of any fish, mass mortality or complete cull events.

Some treatments may only be treated under prescription or recommendation of our veterinary provider (CFAARM). Any fish that require culling (for purposes other than harvest or consumption) are humanely euthanized using a TMS-222 overdose as recommended by the American Veterinary Medical Association Guidelines for Euthanasia. Fish that are deemed moribund, or in a state of suffering, will be euthanized as quickly as possible and documented.

5.3 Water Quality

5.3.1 Life Support Systems

5.3.1.1 Nursery

The nursery that Manna will utilize is a biosecure building in which only authorized and trained employees may work. The nursery recirculating aquaculture systems are outfitted with filtration, sanitation, aeration, temperature control and circulation peripherals to allow fish to be cultured safely in densities of approximately 40 kg/m3. Low discharge filtration allows the systems to be operated at high densities while minimizing the environmental impact. The minimal effluent from this environmentally sustainable system is captured and repurposed to mature other systems or filtered and repurposed to grow plants.

Brood animals were collected from an area within 100 km (60 miles) of the net pen site using hook and line. The collected broods were then transported to the University of Southern Mississippi's Thad Cochran Marine Aquaculture Center (TCMAC) in Ocean Springs, MS. The fish were treated for ectoparasites using Praziquantel and then consolidated in a tank for a 30-day quarantine period. During this period brood fish were treated with chelated copper sulfate to mediate the risk of parasitic infections. Following the end of that process, the fish were sexed, and moved to separate systems for reproductive maturation. A photo-thermal manipulation schedule induces the fish to volitionally spawn. Viable spawns are collected and assessed for fecundity and fertility. Spawns of appropriate size and fertilization rates are consequently stocked in incubation systems where they are allowed to hatch. Hatch rates are assessed at the 24-hour mark. Post-hatch larvae from incubators with the highest hatch rates are then stocked in larval rearing systems. A standardized protocol is used for rearing the fish to the juvenile stages. Once the juveniles are fully weaned onto a formulated crumble or extruded pellet dry diet they are moved into progressively larger systems until they reach a size appropriate for transport and transfer to the net pens. During the nursery and grow-out periods, the fingerlings are fed aggressively at a rate of 8% and 5% body weight per day, respectively. Feed is delivered into the systems both manually and through automated feeders. Formulated diets have a 47-52% protein content to promote growth. Conversion ratios during these periods are estimated to be between 0.8 and 1.5. When the fingerlings reach a size appropriate for transport and transfer to the net pens, a subsample of the fingerlings is taken from the systems and assessed for health. Healthy fingerlings are carefully harvested from the systems, weighed, and stocked into live transport systems for the transfer to the net pen site for offshore grow-out.

5.3.1.2 Offshore Grow-Out Pens

Manna makes use of an offshore net pen grow-out system; comprising the StormSafe Submersible Net Pen and a support vessel or feed barge containing feed, feed delivery system, monitoring equipment, communications and power supply. All juveniles will be transported from the land-based nursery to the offshore site in dedicated circulation tanks. The transport and transfer process is detailed in the supplemental data document.

5.3.1.3 Monitoring/Alarm System

The nursery husbandry protocols at TCMAC entail the collection of water quality data on a daily basis. Data on water quality are collected using hand-held multiparameter meters and test strips. Additionally, the aquaculture systems can be monitored remotely using a monitoring system so the husbandry team has continuous monitoring capabilities. When system function is lost, the monitoring system sends out an automated message to a user-defined list of recipients. An audible and visual on-site alarm is also triggered ensuring fast response time to potential system issues. The probes used for water quality data collection are calibrated daily.

Grow-Out: At several locations around the offshore site, all water quality parameters will be monitored on a daily basis using built-in or handheld probes. Built-in sensors are controlled through the monitoring system and continuously measure oxygen saturation and temperature in each net pen, as well as pH values and water pressure. The monitoring system has built-in software for tracking trends in oxygen, flows, and pH in the net pens.

The monitoring system enables staff to set alarm set points for the different measurable parameters. It is possible using this system to set upper and lower limit set points which will trigger an audible alarm and will relay to the auto dialer and call those who are designated to be on the on-call list.

5.3.2 Water Quality Analysis

Manna uses a suite of sensors to quantify nitrite and alkalinity. Handheld monitors and probes are used to monitor TAN, pH, chloride, nitrate, conductivity, and TDS concentrations. All water quality instruments are calibrated at set intervals to ensure accurate and precise readings. All samples are obtained observing the strictest biosecurity protocols and analysis is conducted by trained personnel in the on-site laboratory. Water quality analysis of the offshore farm will likely include all of the aforementioned parameters, and is subject to additional guidance from the EPA regarding environmental monitoring. Water quality will be monitored using a combination of handheld monitors and built-in sensing packages located throughout the farm. All measurements will be conducted with precisely calibrated instrumentation and reviewed on-board the support vessel and/or feed barge.

Interpretation of the results is conducted by Management and if limits are approached or exceeded, corrective action will then be taken immediately. Water quality fluctuates daily due to animal respiration, system cleaning and fish behavior, however Manna staff is educated in the interpretation of these fluctuations and are aware that normal deviation from ideal parameters does not always constitute a threat to animal welfare.

5.3.3 Aeration

Nursery: Carbon dioxide build up in the systems is monitored on a frequent basis. Carbon dioxide is off-gassed through water agitation and within the recirculating system in areas like the moving bed bioreactors and degassing columns. Agitation of the water within the tank also with air diffusers helps degas carbon dioxide build up in the pump pit from the system.

The building's HVAC and air circulation exhausts unwanted gasses away from the culture area.

Grow-Out: No supplemental aeration will be provided at the offshore net pen sites. The net pens rely on the aerated mass of ocean water to maintain appropriate dissolved gas levels.

5.4 Fish Observations

Nursery: Feeding in the nursery is carried out in part by hand (manually) by qualified aquaculture technicians and by automated feeders. The manual feedings are important since they provide an opportunity for the qualified staff to make observations on the well-being of the fish. Odd behavior like reduced interest in the feed, aggression, or odd swimming patterns are logged in the daily data logs. Observations like these are important in helping the supervisors and managers that audit data daily in determining if there are any issues with stressors or disease that warrant further investigations or treatment.

Grow-Out: Feeding in the grow-out net pens will be done manually in early phases when production is relatively low, and then using an automated system as more net pens are added. Staff are trained to constantly monitor behavior when present during feed distribution and via remote video methods.

Staff are trained to visually observe the fish stock during feeding, cleaning, maintenance, and general walk through. Mortalities are checked for lesions, markings, and scale loss. Any abnormalities are recorded on the daily worksheets and conveyed to management.

Feeding response, increased mortalities and physical appearance are all noted on worksheets and Management is notified of changes. All feed types, sizes, and amounts are adjusted by Management.

Management uses all available data to determine if a cohort is not progressing and compare this progress to pre-set production targets. Negative trends in growth are analyzed to discover problems and implement appropriate measures in an attempt to correct. In cases of poor performing subsets of the cohort we would grade and cull under-achieving stock.

Nursery: Stocking densities will be maintained at approximately 30 $\frac{kg}{m^3}$ or less.

Grow-Out: Stocking densities will be maintained at 25 $\frac{kg}{m^3}$ or less.

5.5 Estimation of Fish Size and Population

Staff are trained to take periodic samples of weight and length measurements. Data are then used to calculate the average size of each cohort in each tank/net pen at a specific time so that Management can make appropriate husbandry adjustments.

Upon fish movements, individuals are counted and graded via dedicated, industry-proven equipment that will be in place at both the nursery and offshore farm.

<u>Daily mortality numbers are used to adjust the total number of fish in any tank/net pen.</u>

5.6 Fish Handling

5.6.1 General

Careful and proper handling of fish is essential to maintaining a stress-free culture environment to produce healthy fish. Manna staff who perform fish handling procedures are trained in appropriate handling techniques via instruction from senior staff and the SOPs.

In general, when manually handling fish, an employee is to wet their hands before making contact to protect the fish's slime coat.

When returning fish to the water, employees are to do so gently, and fish slides are to be constructed in a way to minimize damage from impact. The fish's head should be facing into the current.

No fish will be out of water during counting, weighing, or grading. To measure length, a small subsample of fish will be anesthetized following IACUC protocols for handling live vertebrates. The anesthetized fish will be removed from water briefly to measure length, and then immediately returned to water. Fish that do not recover well from the anesthetic will be culled and euthanized following the IACUC protocols.

Any equipment to be used for the job at hand must be thoroughly checked to ensure that no injury will be caused to the fish as a result of the handling process. Fish will be monitored on a continuous basis throughout the handling process with careful consideration being given to any indicators of stress. This monitoring period is continued afterwards until such time that the management feel is necessary and/or the fish are displaying normal behaviour patterns.

Transfers of fish from one tank to another, or from tanks to net pens, are always documented. It is imperative that different cohorts of fish are not intermingled in the nursery or grow-out. Proper record keeping ensures fish remain with their cohort as they proceed through the production process.

Mortalities and moribund fish are removed and checked daily. The data from the days following a move are used to assess the effectiveness and safety of our movement procedures. Adjustments are made accordingly.

In order to reduce adverse effects during handling, Manna utilizes the common practice of fasting before potentially stressful/large fish movements. It is Manna practice to fast no tank longer than 72 hours.

5.6.2 Juvenile Handling

The health of the juvenile fish is assessed for every batch at the TCMAC facilities in Ocean Springs, MS prior to the transport and transfer to the net pen. A sample of the fish will be sent to an independent lab to confirm they are in good health. This helps confirm that the juvenile fish can tolerate harvest, transport, and transfer to the net pen.

When a batch of juveniles reaches a mean size of 6-9 cm TL, and is ready to be transferred from the land-based systems to the offshore net pens, the following process will be performed. The water level in the nursery systems will be lowered slowly to consolidate the fish and expedite the process. To reduce injury during the transfer process, the juveniles will be lightly anesthetized using one of several standard methods. While staff wait for the juveniles to slow down, a certified bench scale will be set up with a bucket of clean water from the system, and tared. Transfer buckets and shallow dip nets with soft netting (to prevent abrasion-type injuries) will be utilized to slowly and carefully remove small amounts of juveniles at a time from the system, and transfer them into the bucket on the scale. The transfer bucket will be used to repeatedly dip a small number of fish out of the system. That transfer bucket will then be poured through the shallow dip net to separate fish from water, a few at a time. This is a quick process, and the net will be held at the water's surface to minimize injury. The net will be quickly emptied into the already-tared weighing bucket. The new weight will be recorded and is representative of the juvenile wet weight. An appropriate sub sample of the lightly anesthetized juveniles in the system will also be individually weighed and counted to quantify juvenile mean weight, a number that will later be used to quantify abundance. Total biomass of the batch will be quantified. The biomass data will be used to determine the total amount feed to be offered based on the feeding rates of fish of that size as a function of percent wet body weight. To minimize potential losses due to cannibalism, the larger cohorts of every sample will need to be separated from the rest of the population using a grader. Grading will occur when the transfer buckets are poured through a grader already floating in the live transport systems. The excluded fish will be weighed at the end to subtract the graded weight from the total biomass.

The juveniles will be transferred into live transport systems (hauling bins), that will be insulated and outfitted with an air delivery manifold. This will ensure pure oxygen will be delivered into the containers during the transport from Ocean Springs, MS to Pensacola, FL, an approximately 2-hour drive. Fine-pore ceramic oxygen diffusers will help inject oxygen into the containers in an effective and efficient manner to maintain dissolved oxygen levels between 7 and 9 mg/L during the transport.

At the Pensacola operations and staging site, a crane will be utilized to lift the 1000-liter capacity bins, one at a time, onto the vessel to be transported to the offshore farm. Onboard, during the taxi to the site the container water will be partially exchanged with ambient water to begin the pre-stocking acclimation process. Oxygen delivery to the containers will continue during the taxi to the site. Once on site, the acclimation process will continue until the water parameters in the bins match those in the net pens. Juvenile recovery will be visually assessed at that time. Once the fish are showing clear signs of recovery, an FDA approved, reinforced PVC hose will be connected to the hauling container drain port. The internal discharge port gate will be opened inside the container, and the container contents will be gravity-discharged directly to the interior of the net pen. This method reduces the risk of accidental discharge of juveniles outside the net pen. To ensure the discharge hose has no fish stuck in it, the hose will be flushed with water between bin transfers and at the end, before disconnecting or removing the discharge end from the net pen. Dive teams will monitor the fish entry to the net pens throughout this process, and staff will monitor the top-side operations during the transfer from the containers to the net pens. All precautions will be made to minimize the stress on the fish during the transfer and stocking procedure.

To establish that the juveniles are recovering well from this transfer, as well as any other similar moving or sampling process, the juveniles will be allowed to adjust to conditions for several hours, traditionally until the next morning. After the adjustment period, feed will be offered to them manually and qualified staff will verify the juveniles are eating. The biomass data collected prior will help inform staff and minimize feed waste.

5.6.3 Grading and Fish Movement

Juveniles will be graded to separate the larger cannibalistic cohorts from the rest of the population. Floating graders will be placed in the systems to which the fish are being moved and the weight of the graded fish will be quantified and subtracted from the total. Floating graders or automated graders can be used for this process; fish well-being, grading effort, and grader cost will be used to determine which is more appropriate for the size of this operation and the grading frequency. Larger juveniles will be held in separate systems to be grown separately from the rest of the population. Once the appropriate quantity of juveniles reaches a pre-determined size, they will be transferred from the nursery to the offshore grow-out.

Regardless of Management's decision to grade a cohort, fish must be moved to larger tanks as they grow. All fish movements are accompanied by an accurate means of counting the number of fish moved into the new culture unit. This can be achieved using an electronic fish counter or an experienced member of staff.

It is at this point that the fish are to no longer be considered the responsibility of the Manna nursery and are no longer subject to any nursery specific procedures, standards, or regulations.

Harvest is defined as the transferring of fish from grow-out net pens into a unit for transport back to shore. Harvested fish will most likely be placed in designated totes with a saltwater ice-slurry which will stun and subsequently kill the fish. Alternatively, other means of slaughter such as cutting / bloodletting, sharp blow to the head, electrical stunning, etc. may be used. When fish arrive at the shore facility, they will be unloaded and transferred to the buyer / processor.

It is at this point that the fish are to no longer be considered the responsibility of the Manna production crew and are no longer subject to any production specific procedures, standards, or regulations.

All fish movements are documented by Management or senior staff and cohorts are never mixed in a nursery tank or grow-out net pen.

5.6.4 Weighing or Automated Approximation

Weighing the fish or approximating size enables adjustments to feed sizes to be made, based on growth of the fish. The increase in biomass of the tank/net pen can also be determined, based on the increase in the weight of the fish minus the amount of mortalities removed. Once biomass is determined, the amount and/or size of feed to the tank is adjusted to meet production goals.

Batch weighing consists of obtaining samples from different locations in the tank, i.e. center, middle and bottom. This is needed to obtain as the most representative sample of the fish in the tank.

The fish are netted from the tank into a bucket or bin of water. The weight of the fish in the bucket is recorded and then the fish are counted back into the tank.

$$\textit{Fish weight} = \textit{Sample weight} \div \textit{Number of fish}$$

The average for the three samples is given as the average fish weight per tank. This method is dependent on the operators obtaining as representative a sample as possible.

Management may also take additional fish measurements such as length and individual weights.

Grow-Out net pens may also make use of automated video estimates of size in order to make more efficient time of the production crew prior to embarking.

5.6.5 Therapeutants and Prohibited Substances

Management reserves the right to use any drug of Low Regulatory Priority as defined by the FDA. Manna currently uses the following. A complete list of Low Regulatory Priority drugs is available in **Appendix IX**.

<u>Currently Used Therapeutants</u>

Food grade sodium chloride, as an osmoregulatory aid and parasite treatment

Food grade ice, to reduce metabolic rate

Sodium bicarbonate and/or carbon dioxide gas, as an anesthetic

Povidone iodine, as a disinfectant

Acetic acid, as a water treatment and dip to treat parasites

Manna also uses drinking water grade sodium hydroxide and sodium thiosulfate as water treatments as necessary.

Any additional chemical or therapeutic treatments used are subject to Management authorization and/or veterinary oversight. In the case of all treatments on site it is essential that strict records are kept in each instance in relation to the type of tank being treated, duration and quantity of chemical used for the treatment.

During and after each treatment, and regardless of the type of treatment, the health and welfare of the fish are paramount. The fish are regularly examined visually and all necessary life support parameters are monitored continuously during the treatment.

Tricaine mesylate (TMS-222) is approved for use as an anesthetic by the FDA. This use requires a 21 day withdrawal time. Manna will only use TMS-222 to euthanize culled fish and never as an anesthetic for fish to be used for human consumption.

<u>Manna will not accept any fish or feed from nations that use the following substances:</u>

<u>Prohibited Substances</u>

The authorities in the United States and Canada have banned drugs using the following compounds for use in aquacultured food fish:

The United States:

Chloramphenicol;

Nitrofurans;

Fluoroquinolones and Quinolones;

Malachite Green;

Steroid Hormones;

Clenbuterol;

Diethylstilbestrol (DES);

Dimetridazole, Ipronidazole, and other Nitroimidazoles;

Furazolidone, and Nitrofurazone;

Fluoroquinolones;

Glycopeptides.

Canada:

chloramphenicol or its salts and derivatives;

a 5-nitrofuran compound;

clenbuterol or its salts and derivatives;

a 5-nitroimidazole compound;

diethylstilbestrol or other stilbene compounds.

5.6.5.1 Antibiotics

Antibiotics may only be used if authorized by Management and prescribed by the attending veterinarian. The dosage and quantity of the antibiotics is rigidly adhered to and the medication is typically mixed in with the food and administered as such.

5.6.6 Vaccination

Vaccination may not be utilized at Manna unless recommended by a veterinarian. If any vaccines are to be administered, they must be authorized by Management, in conjunction with the oversight of the attending veterinarian. If vaccines are used, separate protocols will be developed in the SOP manual for either immersion (dip/bath) or injectable formulations.

5.6.7 Euthanasia

Occasionally it is necessary to sacrifice fish in order to accurately determine a disease diagnosis, for routine veterinary health assessments, or to end the suffering of a moribund fish. Fish for these purposes are humanely euthanized in an overdose solution of TMS-222, or with any other standard, humane method.

This effectively results in a rapid and irreversible loss of consciousness. As with all mortalities, any euthanized fish are recorded along with the date and tank/net pen that they originated from.

In the instance that a fish is to be consumed the intentional killing will be referred to as slaughter and will be killed via cutting and bloodletting, a sharp blow to the head, electrical stunning, etc.

5.6.8 Mortality Events

Daily mortalities within normal/expected parameters that occur on site are stored securely then disposed of carefully per the SOPs. Personnel are trained in the facility's accepted method of mortality disposal and always must ensure that biosecurity is maintained. They must always wear gloves and thoroughly disinfect immediately after handling all mortalities. Any buckets or equipment used to contain the mortalities must be disinfected after use and are marked for easy identification.

In the unlikely event there is mass mortality on site, all mortalities need to be disposed of in a safe and bio-secure manner. The causes of such events and response procedures will be discussed in the Fish Disease section (Section 6) of the FHMP. The process for disposing of large numbers of fish depends on the volume and weight of fish at the time of the event.

6 Fish Disease

A sole-source juvenile supplier with an excellent broodstock health history, an enclosed hatchery design, and thorough biosecurity and husbandry practices all serve to minimize risks of exposure to pathogens, and/or the subsequent development of disease in all Manna fish populations.

Suppliers may be subject to Manna oversight and must supply upon request health records and/or samples to be tested by Manna or a third-party health authority.

However, even with the above control measures in place, Manna Management recognize that the possibility still exists where a pathogen could enter the system; a tank, a net pen, and result in a disease outbreak. An outbreak is defined "*as an unexpected occurrence of mortality or disease"*.

An outbreak would result in a complete lock-down of the affected area and restricted entry to the site. Manna personnel would also be restricted in their movements and even more stringent biosecurity/disinfection procedures would be enforced. In addition, all appropriate personnel (including the attending or consulting veterinarian) will be notified as soon as possible. These measures are required in order to keep a disease contained until such time as a proper and accurate diagnosis can be made and a course of treatment or other directive is put in place.

6.1 Identification of a Disease Outbreak

All staff are made aware of any distinguishing signs of potential health problems with the fish in a tank or net pen. These signs include but are not limited to:

Lethargy, grouping of the fish on or near the surface of the water or near inflows
Increase in mortalities
Loss of appetite
Change in colour
Gasping at surface
Lesions
Trailing fecal casts
Pale gills
Abnormal swimming behaviors, loss of equilibrium

Management will then consult all the records pertaining to the affected tank or net pen. In certain cases, there may be environmental factors which would cause some or all of symptoms above. An examination of water chemistry parameters will assist in this determination and can be carried out expediently. However, if there are no issues with any environmental factors, veterinary intervention is required.

Depending on the severity of the outbreak, Manna may perform certain in-house tests (e.g. skin scrapes, gill clips, fecal/intestinal squashes, collection of tissues for histology, etc.). On-site necropsies may be performed by trained staff under the supervision of the veterinarian. Alternatively, it may be necessary to send samples of fish to the CFAARM laboratory for necropsy. When the fish are dispatched for examination a full history of the tank must accompany the samples.

All in-house fish sampling procedures will be conducted by the management team in the dedicated lab area, which will be completely disinfected with hydrogen peroxide. Any staff/equipment used to retrieve the samples will be subject to disinfection and disposal as required.

Depending on the severity of an outbreak, certain additional steps may be required by management through the issuance of a directive that will be adhered to by all Manna personnel. The objective is to keep the pathogen load as low as possible and to prevent the spread of the problem.

6.1.1 Isolation

Until specific veterinary recommendations can be obtained for an outbreak, access to all tanks in the nursery or grow-out systems should be limited to essential personnel responsible for those tanks.

6.1.2 Prevent Fish Movements

No fish will be moved in or out of the Manna nursery or around grow-out systems during an outbreak and only designated staff will be allowed to work in the affected areas where the affected fish are contained. This is at the discretion of Management and subject to veterinary intervention.

6.1.3 Disinfection

All disinfection procedures on site will be rigidly enforced. Biosecurity and containment is paramount. Footbaths containing hydrogen peroxide solution are located at every entrance. Hydrogen peroxide solution will be used as net/equipment baths as well. Disposable gloves will always be used by the operators and hand sanitizer must be used as they enter or leave their work area and general facility.

Disinfection may also include fallowing, which will occur after a system or tank is emptied and dried. If a bacterial or viral contaminant is diagnosed in a system it will be completely emptied, dried, and thoroughly disinfected prior to reuse to break the cycle of infection.

6.1.4 Mortality Disposal

Frequency of collection of mortalities will be increased as needed during an outbreak, and will be performed only by designated personnel. The required PPE for the task will be used and all disinfection procedures outlined in this FHMP and the SOPs will be adhered to. Manna disposes of offshore mortalities by transferring them into designated, secure containers and bringing them back to port for proper land-based disposal.

6.1.5 Diagnosis

As referred to above, the veterinarian may require records, fish, and/or water samples to assist in determining the causative agent. Some of the following may be useful when helping to make a diagnosis:

Source of fish
Period in that culture tank
Dates of onset
Age/Size of fish affected
Recent handling events; fish transfer, grading etc.

Stocking density
Mortality pattern
Feed percentage
Water quality

They will give instructions in relation to the correct sampling procedure required, and the applicable Manna staff will carry these out as instructed. The frequency and scope of sampling of affected or apparently healthy fish will be specified by the veterinarian depending on outbreak specifics.

The fish will be continuously monitored throughout the outbreak and any behavioural changes/feeding response changes will be reported back to the veterinarian. In conjunction, a policy of continuous water sampling will be maintained and delivered to the veterinarian.

6.1.6 Reporting

Where appropriate and in accordance with existing regulations, Management will report the outbreak to State and Federal authorities. A site-specific risk analysis has been made for Manna and is available in **Appendix VII.**

6.2 Treatment

After determination of the cause of an outbreak, and in consultation with the attending veterinarian, any treatments that may be required will be communicated to all applicable Manna personnel.

All medications are handled according to the directions specified by the veterinarian and/or as outlined in the applicable SDS sheet. Medications are to be used only by staff trained in the proper handling.

Medicated feed will be fed only as directed by the veterinarian. The appropriate tank(s) must receive the prescribed amount of medicated feed for the duration of the treatment. All withdrawal times will be strictly adhered to; all nursery and net pens cohorts will be held to the same withdrawal period as the treated cohorts.

If there is excess medicated feed after the completion of the treatment the veterinarian will be contacted to determine its proper handling and disposal.

6.2.1 Treatment Records

Treatment records that must be kept for therapeutant use typically include:

Aquaculture license number and name of holder
Location of facility
Name of prescribing veterinarian
Therapeutants log detailing

- Name of Drug
- Method of administration
- Treatment schedule including date of commencement
- Date of completion
- Name and signature of the person responsible for administering each treatment

Detailed records of therapeutant administration will be maintained during the entire time of any treatment.

7 Appendices

Appendix I

<u>OIE Aquatic Animal Health Code</u>

Sections 1-7 and Section 10 of the World Organization for Animal Health, Aquatic Animal Health Code (2017) are represented in the Fish Health Management Plan. Staff are encouraged to explore the original material and supporting literature.

<u>The FAO Technical Guidelines for Responsible Fisheries #5</u>

"Supplement 2: Health Management for the Responsible Movement of Live Aquatic Animals" is used in preparing this Fish Health Management Plan. Staff are encouraged to explore the original material and supporting literature.

These materials are provided in PDF form for free of charge at the following URLs:

http://www.oie.int/en/international-standard-setting/aquatic-code/access-online/
http://www.fao.org/3/a-a1108e.pdf

- **Appendix II**

Example of Standard Operating Procedure Template

Manna Fish Farms

Policy Name:

Policy Number:

Date:

Date Reviewed or Revised:

References:

Purpose and Scope:

Definitions and Clarifications:

Procedure:

Safety:

➢ **Appendix III**

Potential Pathogens

World Organization for Animal Health (OIE) Listed Pathogens

Pathogens and Diseases Listed by OIE Section 1.3.1 of the Aquatic Animal Health Code 2013 (if detected, these are notifiable by Management, attending veterinarian, and/or the testing laboratory to federal and/or state authorities):

Infection with *Aphanomyces invadans* (epizootic ulcerative syndrome)

Infection with epizootic haematopoietic necrosis virus

Infection with *Gyrodactylus salaris*

Infection with HPR-deleted or HPR0 infectious salmon anaemia virus

Infection with infectious haematopoietic necrosis

Infection with salmonid alphavirus

Infection with viral haemorrhagic septicaemia virus

Infection with red sea bream iridovirus

Important Pathogens of Red Drum (*Sciaenops ocellatus*):

(From Food and Agriculture Organization of the United Nations (FAO); http://www.fao.org/fishery/culturedspecies/Sciaenops_ocellatus/en)

AGENT	TYPE

Vibrio sp.	Bacterium
Streptococcus iniaei	Bacterium
Lymphocystis (Iridovirus)	Virus
Copepods; isopods; branchiurans	Parasite
Enteromyxosis (myxidiosis) Myxidium leei	Parasite
Amyloodinium ocellatum	Parasite
Cryptocaryon irritans	Parasite

- ## Appendix IV

<u>Fish Health Routine Screening Plan</u>

Introduction

This document outlines the routine screening plan and monitoring system in place for fish health at Manna. Manna operates on the basis that fish health is directly related to farm management, nursery husbandry practices, grow-out practices, and water quality. Monitoring fish health is an essential part of fish production on the farm.

Fish cultured at Manna will be routinely monitored for signs of health and disease. All staff will be trained to observe and judge healthy behaviour of fish at the various stages of growth. Key activities of healthy fish can be categorized into physical, behavioral, and feeding response. Healthy examples of each activity are explained below.

Physical: free from scale loss, parasites, injury, lesions, and discoloration

Behavioural: normal swimming and schooling behaviour, normal respiration (opercular movement)

Feeding Response: normally aggressive feed response when feed is administered, no signs of cannibalism

Changes in behaviour, physical conditions of the fish, equipment damage, and malfunctions will be reported to Management in a timely manner.

Early detection is vital to maintain good disease management. Communication between staff and Management is necessary to ensure optimal culture conditions are met to achieve production targets. The routine screening plan below consists of daily, weekly, and monthly checks by staff and Management on site, and also third-party checks performed offsite.

Monitoring by third parties includes biannual fish health screenings from our veterinary provider and water quality assessments performed by an environmental testing laboratory.

Daily	Weekly	Monthly	Biannual	As required
System component Checks	System cleanliness	In-house fish health sampling	Veterinary health checks	External water quality assessments
Fish health, behavior				
Water quality monitoring				
Mortality classification				

Daily Monitoring

Daily monitoring of the system components, water quality, and the fish will be carried out by staff, and Management. Daily checks involve system component checks, fish behavior and health, water quality monitoring, and mortality classification.

1. Staff will perform the start of shift walk around to check all the nursery system components are functioning within normal set limits. Abnormal or unusual changes will be noted and reported to management.
    a. Grow-out facilities will be inspected immediately upon arrival for daily duties.

2. Fish behaviour and fish health will be monitored daily by the staff and Management for unusual behavior, lesions, or other signs of disease or pathogens.

3. Water quality is performed 1-4 times daily using the monitoring system and handheld monitoring probes. Water quality is performed by the staff and reports are made to Management to evaluate whether modifications should be made to the system.

4. Mortalities will be categorized daily into groups based on health, growth, and deformities. For example, juvenile mortality could be separated into normal, deformed,

or runt categories. Management reviews the daily mortality by group and notes abnormal or high mortality per tank/net pen, and adjusts feeding, water flow, *etc*. if necessary.

Weekly Monitoring

Monitoring system cleanliness refers to the frequency of tank/net pen cleaning, mortality removal, water clarity, and generally keeping the facility tidy and in order. Adjustments to the cleaning schedule are made accordingly to meet needs. These tasks are recorded on worksheets and operate on a weekly schedule with tasks and frequencies set by Management.

Monthly monitoring

Monthly monitoring will be performed primarily by Management, with assistance from the designated staff and veterinarian. Monthly tasks include routine health sampling and reviewing protocols. Management will make adjustments as needed in order to warrant optimal fish health conditions are met on the farm.

Third Party Monitoring

1. Biannual Fish Health Screenings

Biannual fish health checks will be conducted for pathogen screening during visits from our veterinary service provider CFAARM. All cohorts will be sampled during each vet visit. Fresh mortalities or moribund fish will be sampled on site and histological and virology samples will be analyzed at CFAARM. CFAARM provides Manna with pathogen testing, veterinary services, fish health advice, and consultations.

Fish health screening reports will be stored on record. Management will refer to and review the reports as needed.

Center For Aquatic Animal Research and Management
Stephen Frattini DVM
29 Lake Ellis Road
Wingdale, NY 12504
CFAARM.org

2. Water Quality Assessments

Water will be analyzed as needed, approximately three times per year for general water chemistry parameters and trace metals involved in normal water testing. Manna water samples will be sent to a pred-determined lab for analysis.

[Lab; Address]

➢ Appendix V

Manna Basic Fish Health Sampling
With support from CFAARM

General Sampling Methodology

5-6 fresh dead fish (within 1 hour is best), use MS-222 to euthanize fish , use moribund fish (not dead fish) as well as healthy fish as a control.

All dissecting tools are to be disinfected in 70% isopropyl alcohol before and after use, and thoroughly disinfected for each fish. A new scalpel blade will be used for each fish.

If PCR samples are to be taken to send samples to CFAARM, scalpel blades will be sterilized by flaming and 70% isopropyl alcohol before collecting tissues.

Eyes

Look for cloudy eyes, exophthalmia (pop eye, fluid behind the eye, gas bubble like the bends), and cataracts

Gill sample

Look at gills with forceps. Should be a bright red color, not pale.

Can use 1 slide to take several gill filament samples from the second gill raker from different fish.

Cut out ½ cm portions of filaments with scissors, place on slide with 1 drop of clean culture water, and cover with cover slip. Do not take the gill arch.

Look under microscope on 10-20x for parasites, moving bodies, hyperplasia, gas bubble disease (hemorrhaging, blood pockets, frank bubbles).

Place gill filaments in 1mL centrifuge tube with lid. Add saline water and crush with pestle. Save sample.

Skin scrapes

Look for skin darkening, reddening, hemorrhaging at the base of the fins, or reddening of the mouth.

If a lesion is present you can sample it by cutting around the lesion under the skin (don't cut into the flesh), use the transport medium swab to sample the lesion.

Use slide to scrape above the midline with the scales of the fish, and at the base of the fins.

Put 1 drop of clean culture water on sample and cover with cover slip.

Look under the microscope for parasites, etc. Parasite examples are circular *Trichodina*, *Gyrodactylus salaris* (salmon fluke), *Amyloodinium ocellatum* (marine velvet), *Hexamita* (hole in the head).

Look for a significant number of parasites present in all fish.

Using 1µL disposable loop plate skin scrape mixture onto primary plate and streak it well using whole plate.

Waste sample

Using scalpel gently press along intestine track to remove solid waste.

Put waste on slide with cover slip and look under microscope.

Look for swimming bodies, circular or football shaped circles which indicate the presence of parasites.

Kidney sample

Dissect fish and take kidney sample using scalpel and 1µL disposable loop. Take sample from mid-kidney making vertical cut through air bladder.

Streak sample on bacterial growth agar plate.

Looking for signs of bacterial kidney disease (pale white kidney or white granules).

Send CFAARM a kidney squash for BKD for acid fast or gram stain testing. Send on 2 slides. Squash sample of kidney, do not use water, wipe off using slides to save one layer of sample on the slide.

Normal healthy kidney has a thin, dark red color.

Plate other lesions if seen on inside of the fish.

Gastro Intestinal (GI) track sample

Spread out GI tract below length of fish.

Using scalpel cut a mid-length sample of the track, place it on a slide and squish the sample with a cover slip.

Cut into the intestine and use transport medium swab to collect sample.

Cut open the stomach to see feed contents.

Histology

Fresh histological samples to be removed and saved in formalin to send to CFAARM.

Gill, liver, kidney, spleen, heart, brain, stomach wall, intestine and muscle samples removed. 3-4mm samples collected. Not necessary to keep different samples in separate areas of the cassette or to keep fish samples separate per cassette.

Gill filament sample with arch cut from the second gill raker.

Scoop and lift up a sample of the kidney

Spleen under GI tract (left side, small red), send whole spleen.

Remove and send half of the liver.

Cut a horizontal section of the heart (containing bulbus, ventricle and atrium)

Brain sample: cut through fish behind the eye with scalpel or scissors and pick out brain with forceps.

Cut section of muscle with skin on top side of the fish using scissors or scaple..

Put tissue in plastic container that is already filled with 10% NBF formalin.

Seal container with lid and write on container with permanent marker.

Leave to sit overnight.

In the morning pour off the excess formalin and leave enough to keep the tissue wet.

Put a paper towel on top of the tissue to prevent movement.

Virology

Heart, liver, kidney, spleen sample collected as above and put together in a 15mL centrifuge tube with saline solution.

Blood

Not sampled at Manna.

Note: Described items will be maintained in inventory at Manna or provided by CFAARM.

Appendix VI

Example: Manna Routine Fish Health Sampling

Date: ____________________

Time: ____________________

Name: ____________________

Tank # ____________________

Fish # ____________________

Fish group ____________________

External

Gills	
Gill Sample	
Skin	
Skin Scrape	
Eyes	
Mouth	
Fins	
Waste Sample	
General behavior & external comments	

Internal

GI tract	
Feces	
Swim bladder	
Kidney	
Spleen	
Heart	
Liver	
General internal comments	

Signature ____________________

➢ Appendix VII

<u>Site Specific Risk Analysis for Diseases</u>

Manna uses all pertinent information in taking into the account all risks associated with the production of all aquacultured species. Pathogens can enter the facility in the following ways:

Purchased stock
Water
Pests as disease vectors
Visitors

All stock that is brought into the TCMAC facility is tested to ensure that the stock is healthy for continued culture; this may require CFAARM to visit and sample directly from the supply for confirmatory health assessments. Fry/juveniles that are brought on site from approved external companies would be maintained in quarantine facilities prior to movement into the final nursery system. Samples would be collected weekly to assess health of the imported animals.

Hatchery and nursery water is made up of well water pumped from an on-site well at the TCMAC in Ocean Springs MS and mixed with an artificial salt (Crystal Seas-bioassay formula, Marine Enterprises International, Baltimore MD). Mixed water is sanitized using mechanical filtration for solids removal and UV sterilization for sanitation. Regular health screens are also intended to monitor waterborne pathogens via skin scrapes and gill squashes.

The nursery and grow-out areas are limited entry, biosecure areas isolated from the external environment to prevent wildlife incursions. Sanitation is maintained and routine inspections are performed to discourage pests. Pest control, when necessary, uses humane trapping devices.

Access to the grow-out facility is highly limited; being located offshore. Wildlife will have access to the facility, and exclusion of wild fish, birds, marine mammals, and humans will have to be considered as grow-out operations move forward.

When important guests or vets arrive at the facility, they are given onsite boots or boot covers to wear and a lab coat to cover their clothing. Visitation is screened by Management. Visitors are screened and there are limitations and restrictions on visitors that have recently visited other fish farms or been in contact with marine animals or the marine environment.

Additionally, employees have personalized uniforms that they must change into when arriving for each workday and the clothing stays in their lockers at the end of their shift. There are washers and dryers located at the land-based facility so that the employees may keep their own uniforms clean.

➢ Appendix VIII

Water Quality Considerations

These considerations mainly apply to the nursery system, though automated monitoring and possible manual testing will be implemented at the offshore grow-out facility.

NITROGENOUS WASTES

Ammonia - Very Toxic
Nitrite – Toxic
Nitrate- Least-toxic

Ammonia

Ammonia occurs in ionized ($NH4$ +) form and in un-ionized ($NH3$) form. Un-ionized ammonia is very toxic; lethal concentration is as low as 0.1 ppm. Sublethal levels of $NH3$ causes reduced growth and gill damage.

Testing- Ammonia is tested at least once daily (and possibly more as needed).
Remedial Measures- $NH3$ levels above 0.1 ppm require remediation by increasing make-up water, reducing feeding, removing solid waste, and lowering temperature or pH.

Nitrite

Ammonia is oxidized to Nitrite by *Nitrosomonas sp.*

Testing- Is tested daily using a colorimeter
Chlorides should always be at a concentration that is 20x higher than nitrite

Nitrate

Final product of biofiltration; Nitrite is oxidized to Nitrate by *Nitrobacter sp.*

Testing- Tested daily
Removed by sewering water

ORGANIC SOLIDS

100% of organic solids come from fish feed via waste feed, fish feces and bacterial floc.
Solid wastes are classified into 3 size categories: dissolved, suspended, and settleable solids
Smaller particles are more difficult to remove & more dangerous to the fish.

Settleable Solids (will settle in 60 minutes)

Harbors fungus and bacteria. High limits indicate a mechanical issue

Testing- Imhoff Cone as needed
Remedial Measures- Increase water flow and filtration rate

Suspended Solids (larger than 40 microns)
Excessive solids cause gill irritation and fouling. Bacteria on solids attack the gills.

Testing- Indirectly by measuring Secchi disk depth
Remedial Measures- Increase ozone

Dissolved Solids (fine particles smaller than 40 microns)
Particles 5-30 micron cause gill irritation and damage, affects other water quality parameters

Testing- Measure daily
Remedial Measures- Increase water exchange, increase purge time before sale

WATER CHEMISTRY

pH
pH (Hydrogen ion concentration). Optimum range of pH for fish is 6.5-8.2. Deviation results in stress, reduced growth, and increased disease.
pH level should not fluctuate more than + .5 units/day.
Raise pH: Sodium Hydroxide at a is used to raise pH as necessary.
Lower pH: Acetic acid is used to lower pH as necessary

Testing- pH is measured at least daily

Alkalinity
Measure of carbonate (CO3=) and bicarbonate (HCO3-) ions. Alkalinity strongly influences pH, carbon dioxide and nitrification. Nitrification uses 7 grams of alkalinity to consume 1 gram of ammonia.

Testing- Every 4 days at a minimum using colorimeter
Remedial Measures- Addition of powdered food grade sodium bicarbonate.

Salinity (Measure of salt concentration)
Salinity Tolerance - Fish vary significantly in salinity tolerance. To be determined based on species being cultured.
Testing- (TBD)

(In the nursery, chlorides are measured daily; kept at 20 times the nitrite, to protect against brown blood disease)

Hardness (Measures the level of calcium and magnesium in water)
Optimum range of hardness is 100-300 ppm
Testing – Every 4 days at a minimum using titration
Remedial Measures- increase make-up water, or add calcium carbonate or calcium chloride

DISSOLVED GASSES

4 dissolved gases impact tank culture: oxygen, carbon dioxide, nitrogen & hydrogen sulfide.

Dissolved Oxygen
Most critical gas in fish culture, suboptimal levels are <5 ppm. Low oxygen alarms are set by Management.

Testing- Electronic meters attached to an alarm system. Alarm limits set by Management.
Remedial Measures- Ceramic oxygen stones (or other aeration method) attached to an emergency oxygen system

Carbon Dioxide
A by-product of fish and bacterial respiration, optimal levels of carbon dioxide are 5 to 10 ppm. Maximum of 20 ppm, in these systems
Testing – Daily testing using titration
Remedial Measures- Increase system aeration or oxygen injection.

Dissolved Nitrogen
Inert gas, source is pump cavitation and venturi, causes bubbles in fins in supersaturated levels

Testing – Indirectly through TGP testing using a probe as needed
Remedial Measures - Increase aeration, fix broken equipment

Hydrogen Sulfide
Causes by the anaerobic decomposition of organic matter containing sulfur, has a rotten egg smell. Any amount is a sign of problems

Testing – An occupational gas probe as needed
Remedial Measures - Increase aeration and water exchange rates

➢ Appendix IX

<u>Low Regulatory Priority Drugs in Aquaculture</u>

Acetic acid, as a parasite treatment

Calcium chloride, as an egg hardener and to maintain osmotic balance during transport

Carbon dioxide gas, as an anesthetic

Fuller's earth, to reduce egg adhesiveness

Garlic, to control sea lice in salmonids

Ice, to reduce metabolic rate during transport

Magnesium sulfate, to treat external infestations

Onion, to deter and treat external parasites in salmonids

Papain, to dissolve egg gel matrices

Potassium chloride, to prevent shock and stress and aid in osmoregulation

Povidone iodine, to disinfect eggs

Sodium bicarbonate, as an anesthetic

Sodium chloride, to aid in osmoregulation and prevent shock

Sodium sulfite, to improve hatchability in eggs

Thiamine hydrochloride, to prevent thiamine deficiencies in salmonids

Urea, to reduce adhesiveness of fish eggs

Tannic acid, to reduce adhesiveness of fish eggs

- **Appendix X**

GULF COAST RESEARCH LABORATORY

AQUACULTURE DEPARTMENT

STANDARD OPERATING PROCEDURE: SOP-AH-01

TITLE: ANIMAL HUSBANDRY BIOSECURITY

PRINCIPAL INVESTIGATOR : Dr. Reg Blaylock
DATE:______________ **Approval Signature**: ____________________________________

1.0 PURPOSE

Given the considerable resources expended to acquire and maintain broodstock and the need to ensure production of juveniles, a quality fish health environment must be maintained. Biosecurity is the process through which the animals and facilities are maintained at the highest possible quality. This SOP defines procedures that will be practiced in the animal husbandry facilities during the broodstock acquisition, quarantine and maturation phases. The biosecurity procedures are based on **1) Access Control,**

2) Personnel Disinfection and Sanitation, 3) Equipment Control, and

4) Equipment Disinfection and Sanitation. These procedures will provide for effective education and training of all personnel in the practice of effective biosecurity. These procedures when adequately implemented will ensure that the stock is maintained in a healthy state in a secure environment.

2.0 GENERAL

Biosecurity is built around 3 pillars –1) Access Control**,** 2) Personnel Disinfection and Sanitation and 3) Equipment Control, Disinfection and Sanitation. Technicians must evaluate every activity in this context and plan daily activity patterns to flow from the "cleanest facility" to the "cleaner facility" then to the "dirtiest facility".

CLEANEST → CLEANER → DIRTIEST

3.0 BIOSECURITY EQUIPMENT and MATERIALS

The essential biosecurity equipment and materials include but are not limited to the following:

3.1 Footbath trays and mats
3.2 Footbath Disinfectant (Suggested: Western Quat and VirkonS)

3.3 Hand Disinfectant (The preferred hand disinfectant is AlcoSCRUB (purchased through VWR, Inc.). It is in gel form and is an instant antiseptic cleanser effective against a broad spectrum of microorganisms.
3.4 Disposable Lab Coat/Gloves
3.5 Water Quality Equipment Confined to each Project Facility
(Re: Section 4.2-Equipment Control and Disinfection)

3.6 Surface Disinfectants:

(Suggested: Bleach, Alcohol-ETOH and VirkonS)

3.7 Buckets, Nets and Bleach Bath Vessels

3.8 Signs Defining Access Control and Procedures

4.0 BIOSECURITY PROCEDURES

4.1 ACCESS CONTROL

All animal husbandry facilities doors must remain locked at all times. Access will be limited to authorize personnel only. “Authorized Personnel” is defined as the animal husbandry staff which includes the Program Manager, Hatchery Manager and Technical Support Personnel. Other individuals including guests may gain access through pre-approval from the Program Manager/Principal Investigator.

4.1.1 Biosecurity Signs

There are three biosecurity signs that will be posted at all building entrances to inform individuals that there is a strict biosecurity program in effect.

For those who are authorized to enter the facility, two additional signs shall provide instruction for procedural conduct.

4.1.1.1 Sign 4.1-Figure 1

This sign shall be posted to clearly indicate which facilities

have restricted access. The maintenance and custodial

staff shall be informed that their normal routines must not include those facilities. In the event that the Physical Plant staff must enter the restricted area, program personnel and the Physical Plant manager shall coordinate access. Physical Plant staff shall be expected to follow disinfection and sanitation procedures. Program personnel shall be responsible for ensuring that Physical Plant staff are aware of and follow the procedures while working in the building.

4.1.1.2 Sign 4.1-Figure 2

This sign shall indicate that special procedures are required for anyone entering the facility. Special procedures are defined in Sign 4.1 Figure 3.

4.1.1.3 Sign **4.1-Figure 3**

This sign shall define who is authorized for entry and states specific procedures required for facility entry.

4.1-Figure 1

BIOSECURE

AREA

4.1-Figure 2

DISINFECTION PROCEDURES

<u>AND</u>

PROTECTIVE CLOTHING

<u>REQUIRED</u>

<u>AT ALL TIMES</u>

4.1-Figure 3

ACCESS AUTHORIZATION

DISINFECTION/PROTECTIVE CLOTHING

EQUIPMENT CONTROL

All GCRL Employees and Visitors are Subject to the Following Procedures:

- ***ACCESS AUTHORIZATION*****: Authorized personnel only. Others must be approved by Drs. Lotz or Blaylock PRIOR to visitation.**
- ***DISINFECTION/PROTECTIVE CLOTHING*****:**
  Foot/hand disinfection and lab coats required at ALL times.
  - **Feet- step in an antimicrobial bath solution upon entry and exit**
  - **Hands- gloves required for those in contact with animals, water and equipment. Disinfect hands using provided disinfectant prior to applying gloves. Discard gloves after each use.**
  - **Lab Coats- reuse ONLY if NOT removed from the area**

EQUIPMENT CONTROL**: Confine use to the secured area. All equipment MUST BE disinfected prior to and after use. Label as follows:**

***BSU: Building Location/Identification**

***BIOSECURE USE ONLY**

4.2 PERSONNEL DISINFECTION and SANITATION

Routine hygiene and disinfection procedures reduce the likelihood of pathogen contamination and spread. Therefore, there must be routine disinfection and sanitation of people that enter the facility. This section describes procedures for personnel disinfection and sanitation.

4.2.1 Foot Baths

Disinfectant footbaths are located at the entrance of each building and/or room. When a footbath is present, all individuals must step in footbaths upon entry and exit. Footbaths must contain an abrasive surface and support at least 2 inches of disinfectant. The container must be large enough to accommodate both feet comfortably and allow for thorough foot wiping. For effective foot sanitation, both feet must be placed in the bath then agitated left to right several times.

The preferred footbath disinfectant is Virkon® S, a broad spectrum disinfectant (Refer to Section 5.0 Virkon® S USAGE for AQUACULTURE APPLICATION: Section 5.2.2 Foot Bath). Other type disinfectants such as quaternary ammonium, and potentiated iodine compounds also are acceptable.

4.2.2 Hand Disinfection and Glove Usage

4.2.2.1 All persons entering the facility must apply disinfectant to their hands and wear latex gloves. Hand disinfectants that contain potentially toxic phenol residues should not be used.

4.2.2.2 Hand disinfectant can be any gel, liquid, or foam-based, broad-spectrum, laboratory-grade product containing at least 60% ethyl alcohol.

4.2.2.3 Hand disinfection shall occur as follows:

4.2.2.3.1 Apply at least a nickel-sized dollop of gel to the palm of your hand. Spread the disinfectant to cover the hands.

4.2.2.3.2 Rub hands, including between the fingers, until dry and no longer sticky.

4.2.2.3.3 Apply latex gloves. All persons contacting, water, equipment, or fish **SHALL** wear gloves.

4.2.2.3.4 After glove application hand disinfection shall be repeated when applicable.

4.2.3 Lab Coats

Disposable lab coats shall be located at each building entrance and at multiple workstations within the building. Lab coats are worn to provide a protective barrier between the culture system and any potentially contaminated hands and clothes. Disposable lab coats should be worn by all persons contacting water, equipment, or fish.

Coats worn **WITHIN** the facility may be reused daily **IF** the following criteria are met: 1) they are used to cover street clothes that have not been in contact with other marine animals or seawater and 2) they are sprayed between uses with at least 70% alcohol. In the event a lab coat is worn outside the culture facility it is considered contaminated and must be destroyed.

4.3 EQUIPMENT CONTROL, DISINFECTION and SANITATION

Routine equipment containment procedures reduce the likelihood of pathogen contamination and spread. Equipment (water quality meters, probes/extensions, nets, buckets, sample beakers, blowers, etc.) shall be dedicated to individual rooms to prevent cross-contamination. All equipment will be labeled accordingly to identify facility location. This section describes procedures for the control and disinfection of equipment.

4.3.1 Water Quality Equipment Disinfection

Whenever possible, water quality equipment shall be dedicated to each unique culture area. In the event equipment can not be dedicated to a specific area, samples will be taken in and measured in sanitized beakers or flasks in a secure area rather than measured directly in the tank. All probes and associated parts must be rinsed with distilled or fresh water after each use. Equipment that is not specific to an area shall be rinsed with a minimum 10 % bleach solution or a minimum 70 % ETOH followed by a freshwater rinse before removing it from the area of use. Prior to chemical rinsing, always check equipment manufacturer's recommendations concerning sensitivity to bleach, alcohol or other chemicals.

4.3.2 Other Equipment Disinfection

Nets, buckets, glassware, blowers, feed containers, etc. shall be disinfected with at least a minimum 50ppm chlorine bleach solution for 24 hours. The bleach solution concentration may be increased proportionally to decrease the duration period. However, management shall be consulted for approval of any deviation from the minimum 50ppm 24 hour rule. Equipment that has been subject to a concentrated bleach bath is dechlorinated with a sodium thiosulfate solution (3mg/L). Alternatively, equipment may be disinfected with at least 70% ethyl alcohol that disinfects upon contact, or a 1% VirkonS solution (Refer to Section 5.0 Virkon® S Usage for Aquaculture Application).

5.0 Virkon® S USAGE for AQUACULTURE APPLICATIONS

5.1 Virkon® S GENERAL INFORMATION and PREPARATION

Virkon® S is used in a variety of aquaculture applications and is effective against numerous microorganisms affecting animals: viruses, gram positive and gram negative bacteria, fungi (molds and yeast) and mycoplasma. Virkon® S is manufactured in a powdered formula that is easily diluted for use in manual or machine operations.

Virkon® S is generally prepared in a 2%, 1% or 0.5% solution. All solutions are stable for seven days. Specific application dilutions are defined in

Section 5.2 SPECIFIC AQUACULTURE APPLIC ATIONS.

5.1.1 General Preparation

Determine the appropriate Virkon® S solution as defined by the

Virkon® S dilution chart. Fill a container/vessel with the required quantity of water.

Virkon® S powder must **NOT** be applied directly to the prepared solution water. Measure the required amount of Virkon® S into an approximately 1 liter volume vessel. Add enough water to make a concentrated solution stirring well to dissolve the powder then add to the prepared solution vessel. Stir the solution to mix well.

Virkon® S Dilution Chart			
Quantity of Water	**0.5% Solution**	**1.0% Solution**	**2.0% Solution**
1 mL	**0.005 Grams**	**0.01 Grams**	**0.02 Grams**
1 Liter	**0.5 Grams**	**1.0 Grams**	**2.0 Grams**
3.78 Liters (One Gallon)	**18.9 Grams**	**37.8 Grams**	**75.6 Grams**

One gallon (~3.78 Liters) of a desired solution is sufficient to treat an area of 135 square feet.

5.2 SPECIFIC AQUACULTURE APPLICATIONS

5.2.1 Inanimate Object Disinfection (1% SOLUTION)

5.2.1.1 Soaking Bath Application

Virkon® S is intended to disinfect inanimate environmental objects associated with aquaculture operations including nets, hoses, brushes and other similar equipment. Baths are prepared as defined in Section 5.1.1 and objects are allowed to soak for at least 20-30 minutes. Rinse objects with freshwater after each disinfection event.

All equipment used in the aquaculture setting (tanks, ponds, and all associated equipment) shall be disinfected before each new use.

Note: Do not soak metal objects for long periods. Ten minutes is the maximum necessary contact time.

5.2.1.2 Surface Contact Application

Virkon® S is intended to disinfect inanimate environmental surfaces associated with aquaculture operations including vehicles and wheels, walls, ceilings, floors, decks, storage containers, water proof footwear, dive suits, fishing waders, equipment, utensils and instruments.

Solutions are prepared as defined in Section 5.1.1 then applied with either a cloth, sponge or by manual spraying. Contact time for maximum disinfection is 10 minutes. Rinse objects with a freshwater rinse after each disinfection event.

5.2.2 Foot Bath (0.5%-1% SOLUTION)

Virkon® S shall be used in foot baths in a minimum 0.5 % solution. Solution is prepared as defined in 5.1.1. Each footbath reservoir shall be prepared as defined in Section 4.4.1. Footbath solution shall be changed at least every seven days.

5.2.3 Area Fogging (Wet Misting): (1% SOLUTION)

Virkon® S is recommended for use in fogging or wet misting operations or as a supplemental measure either before or after routine cleaning and disinfection procedures. Misting solutions are prepared as defined in 5.5.1. Fog or mist until the area is moist using an automatic fogger or sprayer. No area rinsing shall be necessary following the fogging/misting procedure. However, rinse the sprayer and all associated parts with freshwater after each use.

5.3 Virkon® S PRECAUTIONARY STATEMENTS

For HANDLING in POWDER FORM:

HAZARDS and PERSONAL PROTECTIVE MEASURES:

5.3.1 Virkon® S powder is extremely corrosive.

5.3.2 Do not get in eyes, on skin or on clothing: Causes skin burns and irreversible eye damage.

5.3.3 Wear protective clothing, gloves, goggles or safety glasses.
5.3.4 Avoid breathing powder. Wear a mask that covers nose and mouth or a full face shield or respirator.
5.3.5 Wash hands and protective equipment thoroughly with soap and water after each handling event.
5.3.6 Remove contaminated clothing and wash before reuse or dispose in the trash.
5.3.7 First Aid: Refer to Virkon® S MSDS (MSDS File located in the Maturation Building).
5.3.8 KEEP away from children and domestic animals.
5.3.9 DO NOT mix Virkon® S with other chemicals
5.3.10 Virkon® S is Hazardous to Humans and Domestic Animals

5.4 STORAGE and DISPOSAL

5.4.1 Storage

Virkon® S shall be stored in a cool dry place, in a tightly closed container AWAY from children and domestic animals.

5.4.2 Disposal

After Virkon® S product depletion, the container shall not be used for storage of feed, chemicals or other products.

After product depletion, the container shall be thoroughly washed with soap and water and disposed of in the trash.

6.0 REFERENCES

VIRKON ® S Literature:

Manufactured by Antec International Ltd

Windham Road,

Chilton Industrial Estate

Sudbury, Suffolk UK C010 2XD

Web site: vircons.com

E-mail: biosecurity @antecint.com

Appendix L:

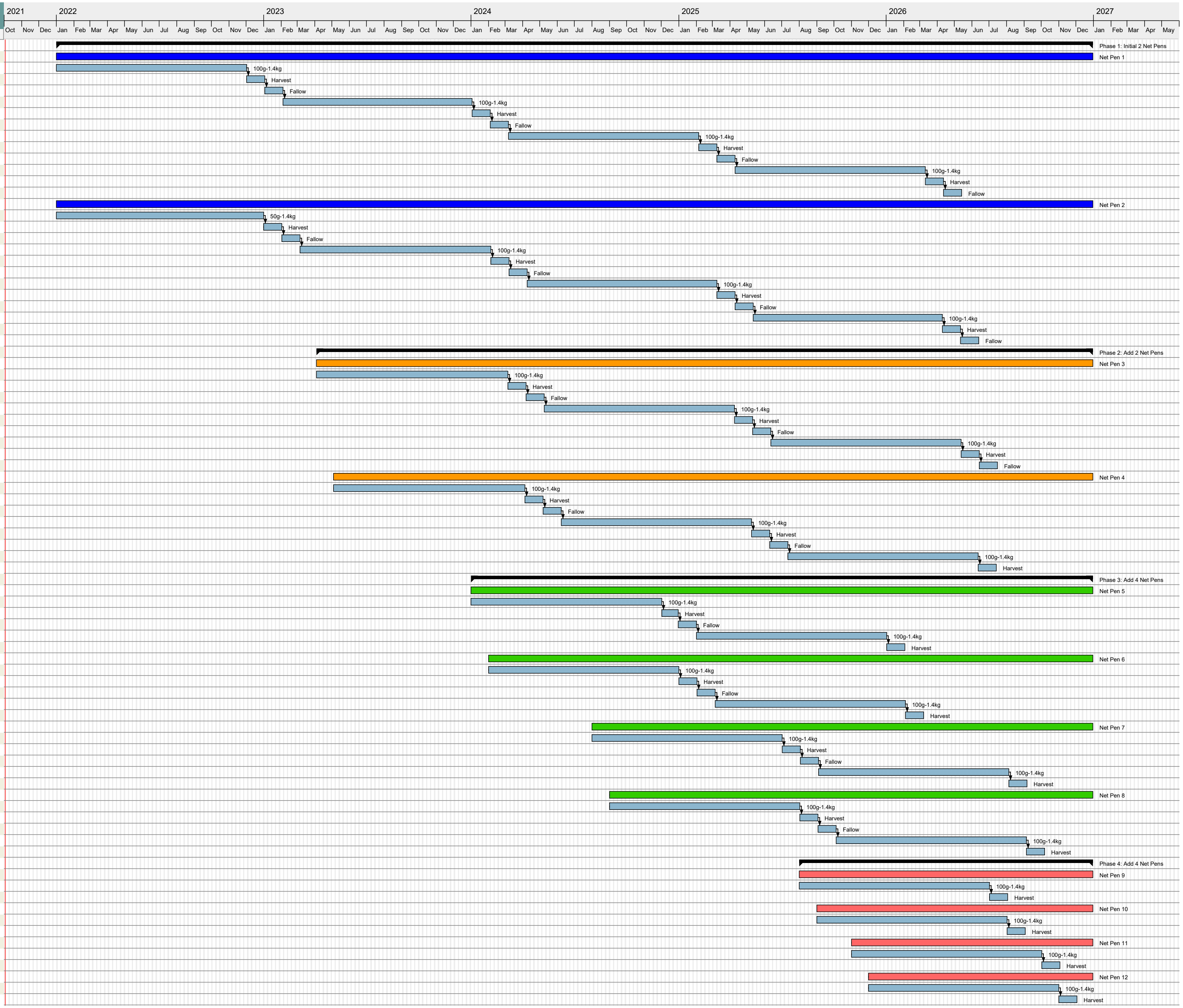
Production Timelines and Information

GOM Production Timeline

Sep 27, 2021

Gantt Chart

Name	Begin date	End date
Phase 1: Initial 2 Net Pens	1/1/22	12/30/26
Net Pen 1	1/1/22	12/30/26
100g-1.4kg	1/1/22	12/1/22
Harvest	12/2/22	1/2/23
Fallow	1/3/23	2/3/23
100g-1.4kg	2/4/23	1/2/24
Harvest	1/3/24	2/3/24
Fallow	2/4/24	3/6/24
100g-1.4kg	3/7/24	2/4/25
Harvest	2/5/25	3/8/25
Fallow	3/9/25	4/9/25
100g-1.4kg	4/10/25	3/10/26
Harvest	3/11/26	4/11/26
Fallow	4/12/26	5/13/26
Net Pen 2	1/1/22	12/30/26
50g-1.4kg	1/1/22	12/31/22
Harvest	1/1/23	2/1/23
Fallow	2/2/23	3/5/23
100g-1.4kg	3/6/23	2/4/24
Harvest	2/5/24	3/7/24
Fallow	3/8/24	4/8/24
100g-1.4kg	4/9/24	3/8/25
Harvest	3/9/25	4/9/25
Fallow	4/10/25	5/11/25
100g-1.4kg	5/12/25	4/9/26
Harvest	4/10/26	5/11/26
Fallow	5/12/26	6/12/26
Phase 2: Add 2 Net Pens	4/4/23	12/30/26
Net Pen 3	4/4/23	12/30/26
100g-1.4kg	4/4/23	3/5/24
Harvest	3/6/24	4/6/24
Fallow	4/7/24	5/8/24
100g-1.4kg	5/9/24	4/8/25
Harvest	4/9/25	5/10/25
Fallow	5/11/25	6/11/25
100g-1.4kg	6/12/25	5/12/26
Harvest	5/13/26	6/13/26
Fallow	6/14/26	7/15/26
Net Pen 4	5/4/23	12/30/26
100g-1.4kg	5/4/23	4/4/24
Harvest	4/5/24	5/6/24
Fallow	5/7/24	6/7/24
100g-1.4kg	6/8/24	5/8/25
Harvest	5/9/25	6/9/25
Fallow	6/10/25	7/11/25
100g-1.4kg	7/12/25	6/11/26
Harvest	6/12/26	7/13/26
Phase 3: Add 4 Net Pens	1/1/24	12/30/26
Net Pen 5	1/1/24	12/30/26
100g-1.4kg	1/1/24	12/1/24
Harvest	12/2/24	12/30/24
Fallow	12/31/24	1/31/25
100g-1.4kg	2/1/25	1/1/26
Harvest	1/2/26	2/2/26
Net Pen 6	2/1/24	12/30/26
100g-1.4kg	2/1/24	12/31/24
Harvest	1/1/25	2/1/25
Fallow	2/2/25	3/5/25
100g-1.4kg	3/6/25	2/3/26
Harvest	2/4/26	3/7/26
Net Pen 7	8/1/24	12/30/26
100g-1.4kg	8/1/24	7/1/25
Harvest	7/2/25	8/2/25
Fallow	8/3/25	9/3/25
100g-1.4kg	9/4/25	8/4/26
Harvest	8/5/26	9/5/26
Net Pen 8	9/1/24	12/30/26
100g-1.4kg	9/1/24	8/1/25
Harvest	8/2/25	9/2/25
Fallow	9/3/25	10/4/25
100g-1.4kg	10/5/25	9/4/26
Harvest	9/5/26	10/6/26
Phase 4: Add 4 Net Pens	8/1/25	12/30/26
Net Pen 9	8/1/25	12/30/26
100g-1.4kg	8/1/25	7/1/26
Harvest	7/2/26	8/2/26
Net Pen 10	9/1/25	12/30/26
100g-1.4kg	9/1/25	8/1/26
Harvest	8/2/26	9/2/26
Net Pen 11	11/1/25	12/30/26
100g-1.4kg	11/1/25	10/1/26
Harvest	10/2/26	11/2/26
Net Pen 12	12/1/25	12/30/26
100g-1.4kg	12/1/25	10/31/26
Harvest	11/1/26	12/2/26



GOM Production Information

	Net Pens	Time (yrs.)	Net Pen Size (m3)	Total Net Pen Vol. (m3)	Harvest Density (kg/m3)	Final Harvest Estimates (kg)	Number of Fish Stocked	% Survival	Number of Fish at Harvest	Initial Size per Fish (g)	Harvest Size (kg)	Initial Biomass (kg)	Final Biomass (kg)
---	1	---	9000	9,000	25	225,000	190,000	90	171,000	100	1.4	19,000	239,400
Phase 1	2	0 to 1	9000	18,000	25	450,000	**380,000**	90	**342,000**	100	1.4	38,000	**478,800**
Phase 2	4	1 to 2	9000	36,000	25	900,000	**760,000**	90	**684,000**	100	1.4	76,000	**957,600**
Phase 3	8	2 to 4	9000	72,000	25	1,800,000	**1,520,000**	90	**1,368,000**	100	1.4	152,000	**1,915,200**
Phase 4	12	4 to 5	9000	108,000	25	2,700,000	**2,280,000**	90	**2,052,000**	100	1.4	228,000	**2,872,800**
													(6,320,160 lbs)

Monthly Maximum Biomass and Feed Rates

	Year 1	Year 2	Year 3	Year 4	Year 5
Biomass (MT / month)	479.6	799.5	1401.4	1532.9	1770.6
Feed Rate (MT / month)	596.1**	1079.4	1723.7	2069.4	2222.1

*Values represent the maximum biomass per month and the associated maximum feed rate per month for the entire farm for each year based on calendar years, tiered production, and the production info seen above.
*Assumes 11-month growout period from 100g to 1.4kg. Actual production will vary depending on ideal harvest size and growth rate.
*Assumes 90% survival to yield maximum biomass and feed values
*Feed rate values were calculated using an average value of 3% of body weight consumed per day and an FCR of 1.5. The 3% body weight average was derived from the assumption that the fish will consume a greater percentage of their body weight in food (~4%) in the initial growout months when they are smaller, and a lesser percentage (~2%) once they grow larger in the later months of growout.

**Year 1 max feed rate does not coincide with the Year 1 max biomass, offset by one month due to harvest month requiring less feed

Biomass Timeline

BIOMASS (kg)

YEAR 1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
PHASE 1												
Net Pen 1	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0	190000.0	209760.0	229520.0	HARVEST
Avg. Size of Fish (g)	165.0	295.0	417.8	533.3	648.9	764.4	880.0	995.6	1111.1	1226.7	1342.2	---
Net Pen 2	21850.0	46550.0	71250.0	84360.0	102600.0	120840.0	139080.0	157320.0	175560.0	193800.0	212040.0	230280.0
Avg. Size of Fish (g)	115.0	245.0	375.0	493.3	600.0	706.7	813.3	920.0	1026.7	1133.3	1240.0	1346.7
PHASE 2												
Net Pen 3												
Avg. Size of Fish (g)												
Net Pen 4												
Avg. Size of Fish (g)												
PHASE 3												
Net Pen 5												
Avg. Size of Fish (g)												
Net Pen 6												
Avg. Size of Fish (g)												
Net Pen 7												
Avg. Size of Fish (g)												
Net Pen 8												
Avg. Size of Fish (g)												
PHASE 4												
Net Pen 9												
Avg. Size of Fish (g)												
Net Pen 10												
Size of Fish (g)												
Net Pen 11												
Avg. Size of Fish (g)												
Net Pen 12												
Avg. Size of Fish (g)												

BIOMASS (kg)

YEAR 2	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
PHASE 1												
Net Pen 1	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0	190000.0	209760.0	229520.0
Avg. Size of Fish (g)	---	165.0	295.0	417.8	533.3	648.9	764.4	880.0	995.6	1111.1	1226.7	1342.2
Net Pen 2	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0	190000.0	209760.0
Avg. Size of Fish (g)	---	---	165.0	295.0	417.8	533.3	648.9	764.4	880.0	995.6	1111.1	1226.7
PHASE 2												
Net Pen 3				31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0	190000.0
Avg. Size of Fish (g)				165.0	295.0	417.8	533.3	648.9	764.4	880.0	995.6	1111.1
Net Pen 4					31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0
Avg. Size of Fish (g)					165.0	295.0	417.8	533.3	648.9	764.4	880.0	995.6
PHASE 3												
Net Pen 5												
Avg. Size of Fish (g)												
Net Pen 6												
Avg. Size of Fish (g)												
Net Pen 7												
Avg. Size of Fish (g)												
Net Pen 8												
Avg. Size of Fish (g)												
PHASE 4												
Net Pen 9												
Avg. Size of Fish (g)												
Net Pen 10												
Size of Fish (g)												
Net Pen 11												
Avg. Size of Fish (g)												
Net Pen 12												
Avg. Size of Fish (g)												

BIOMASS (kg)

YEAR 3	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
PHASE 1												
Net Pen 1	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0	190000.0	209760.0
Avg. Size of Fish (g)	---	---	165.0	295.0	417.8	533.3	648.9	764.4	880.0	995.6	1111.1	1226.7
Net Pen 2	229520.0	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0	190000.0
Avg. Size of Fish (g)	1342.2	---	---	165.0	295.0	417.8	533.3	648.9	764.4	880.0	995.6	1111.1
PHASE 2												
Net Pen 3	209760.0	229520.0	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0
Avg. Size of Fish (g)	1226.7	1342.2	---	---	165.0	295.0	417.8	533.3	648.9	764.4	880.0	995.6
Net Pen 4	190000.0	209760.0	229520.0	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0
Avg. Size of Fish (g)	1111.1	1226.7	1342.2	---	---	165.0	295.0	417.8	533.3	648.9	764.4	880.0
PHASE 3												
Net Pen 5	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0	190000.0	209760.0	229520.0	HARVEST
Avg. Size of Fish (g)	165.0	295.0	417.8	533.3	648.9	764.4	880.0	995.6	1111.1	1226.7	1342.2	---
Net Pen 6		31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0	190000.0	209760.0	229520.0
Avg. Size of Fish (g)		165.0	295.0	417.8	533.3	648.9	764.4	880.0	995.6	1111.1	1226.7	1342.2
Net Pen 7								31350.0	56050.0	71440.0	91200.0	110960.0
Avg. Size of Fish (g)								165.0	295.0	417.8	533.3	648.9
Net Pen 8									31350.0	56050.0	71440.0	91200.0
Avg. Size of Fish (g)									165.0	295.0	417.8	533.3
PHASE 4												
Net Pen 9												
Avg. Size of Fish (g)												
Net Pen 10												
Size of Fish (g)												
Net Pen 11												
Avg. Size of Fish (g)												
Net Pen 12												
Avg. Size of Fish (g)												

BIOMASS (kg)

YEAR 4	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
PHASE 1												
Net Pen 1	229520.0	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0	190000.0
Avg. Size of Fish (g)	1342.2	---	---	165.0	295.0	417.8	533.3	648.9	764.4	880.0	995.6	1111.1
Net Pen 2	209760.0	229520.0	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0
Avg. Size of Fish (g)	1226.7	1342.2	---	---	165.0	295.0	417.8	533.3	648.9	764.4	880.0	995.6
PHASE 2												
Net Pen 3	190000.0	209760.0	229520.0	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0
Avg. Size of Fish (g)	1111.1	1226.7	1342.2	---	---	165.0	295.0	417.8	533.3	648.9	764.4	880.0
Net Pen 4	170240.0	190000.0	209760.0	229520.0	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0
Avg. Size of Fish (g)	995.6	1111.1	1226.7	1342.2	---	---	165.0	295.0	417.8	533.3	648.9	764.4
PHASE 3												
Net Pen 5	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0	190000.0	209760.0	229520.0
Avg. Size of Fish (g)	---	165.0	295.0	417.8	533.3	648.9	764.4	880.0	995.6	1111.1	1226.7	1342.2
Net Pen 6	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0	190000.0	209760.0
Avg. Size of Fish (g)	---	---	165.0	295.0	417.8	533.3	648.9	764.4	880.0	995.6	1111.1	1226.7
Net Pen 7	130720.0	150480.0	170240.0	190000.0	209760.0	229520.0	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0
Avg. Size of Fish (g)	764.4	880.0	995.6	1111.1	1226.7	1342.2	---	---	165.0	295.0	417.8	533.3
Net Pen 8	110960.0	130720.0	150480.0	170240.0	190000.0	209760.0	229520.0	HARVEST	FALLOW	31350.0	56050.0	71440.0
Avg. Size of Fish (g)	648.9	764.4	880.0	995.6	1111.1	1226.7	1342.2	---	---	165.0	295.0	417.8
PHASE 4												
Net Pen 9								31350.0	56050.0	71440.0	91200.0	110960.0
Avg. Size of Fish (g)								165.0	295.0	417.8	533.3	648.9
Net Pen 10									31350.0	56050.0	71440.0	91200.0
Size of Fish (g)									165.0	295.0	417.8	533.3
Net Pen 11											31350.0	56050.0
Avg. Size of Fish (g)											165.0	295.0
Net Pen 12												31350.0
Avg. Size of Fish (g)												165.0

BIOMASS (kg)

YEAR 5	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
PHASE 1												
Net Pen 1	209760.0	229520.0	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0
Avg. Size of Fish (g)	1226.7	1342.2	---	---	165.0	295.0	417.8	533.3	648.9	764.4	880.0	995.6
Net Pen 2	190000.0	209760.0	229520.0	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0
Avg. Size of Fish (g)	1111.1	1226.7	1342.2	---	---	165.0	295.0	417.8	533.3	648.9	764.4	880.0
PHASE 2												
Net Pen 3	170240.0	190000.0	209760.0	229520.0	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0
Avg. Size of Fish (g)	995.6	1111.1	1226.7	1342.2	---	---	165.0	295.0	417.8	533.3	648.9	764.4
Net Pen 4	150480.0	170240.0	190000.0	209760.0	229520.0	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0
Avg. Size of Fish (g)	880.0	995.6	1111.1	1226.7	1342.2	---	---	165.0	295.0	417.8	533.3	648.9
PHASE 3												
Net Pen 5	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0	190000.0	209760.0
Avg. Size of Fish (g)	---	---	165.0	295.0	417.8	533.3	648.9	764.4	880.0	995.6	1111.1	1226.7
Net Pen 6	229520.0	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0	190000.0
Avg. Size of Fish (g)	1342.2	---	---	165.0	295.0	417.8	533.3	648.9	764.4	880.0	995.6	1111.1
Net Pen 7	110960.0	130720.0	150480.0	170240.0	190000.0	209760.0	229520.0	HARVEST	FALLOW	31350.0	56050.0	71440.0
Avg. Size of Fish (g)	648.9	764.4	880.0	995.6	1111.1	1226.7	1342.2	---	---	165.0	295.0	417.8
Net Pen 8	91200.0	110960.0	130720.0	150480.0	170240.0	190000.0	209760.0	229520.0	HARVEST	FALLOW	31350.0	56050.0
Avg. Size of Fish (g)	533.3	648.9	764.4	880.0	995.6	1111.1	1226.7	1342.2	---	---	165.0	295.0
PHASE 4												
Net Pen 9	130720.0	150480.0	170240.0	190000.0	209760.0	229520.0	HARVEST	FALLOW	31350.0	56050.0	71440.0	91200.0
Avg. Size of Fish (g)	764.4	880.0	995.6	1111.1	1226.7	1342.2	---	---	165.0	295.0	417.8	533.3
Net Pen 10	110960.0	130720.0	150480.0	170240.0	190000.0	209760.0	229520.0	HARVEST	FALLOW	31350.0	56050.0	71440.0
Size of Fish (g)	648.9	764.4	880.0	995.6	1111.1	1226.7	1342.2	---	---	165.0	295.0	417.8
Net Pen 11	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0	190000.0	209760.0	229520.0	HARVEST	FALLOW	31350.0
Avg. Size of Fish (g)	417.8	533.3	648.9	764.4	880.0	995.6	1111.1	1226.7	1342.2	---	---	165.0
Net Pen 12	56050.0	71440.0	91200.0	110960.0	130720.0	150480.0	170240.0	190000.0	209760.0	229520.0	HARVEST	FALLOW
Avg. Size of Fish (g)	295.0	417.8	533.3	648.9	764.4	880.0	995.6	1111.1	1226.7	1342.2	---	---

*Biomass projections and size of fish refer to the average biomass present in the net pen for the entire month

*Assumes 11 month growout from 100g to 1.4kg, actual production may vary depending on ideal harvest size and growth rate

*Net Pen 2 incorporates the experimental 50g stock size for its Year 1 growout cycle

*Green values represent months of accelerated growth, during which growth is expected to occur at a higher rate than the remaining months of the growout cycle

*Assumes all mortality occurs by the end of the accelerated growth period (first 2 months for 100g stock, first 3 months for 50g stock)

*Assumes operation will continue beyond the intial 5-year NPDES permit duration

Appendix M:

Red Drum Broodstock Collection

Red Drum Broodstock Collection Detail

Seventeen adult Red Drum (*Sciaenops ocellatus*) (average weight 7.68 kg, average Total Length 91.92 cm, Table 1) were collected from an area south of Fort Morgan, AL centered at 30°12'59.45"N, 88° 1'39.83"W, approximately 62 miles northwest of the proposed Manna Fish farm site (Figures 1, 2). The adult fish were collected using hook and line, and transported to the Thad Cochran Marine Aquaculture Center (TCMAC) in Ocean Springs, MS. Upon receipt, fish were pre-treated with Praziquantel and quarantined under copper sulfate treatment to remove external parasites. Prior to entry into quarantine, each individual fish was implanted with a uniquely coded Passive Integrated Transponder (PIT) tag (see Table 1).

Upon completion of the quarantine process, fish were sexed insofar as possible and transferred into three maturation tanks, each on an independent recirculating system. Two tanks (VC 5 and VC 6) each contain 3 putative or confirmed females and 2 putative or confirmed males. The 3rd tank (RSGO 7) contains the remaining fish. During transfer, fin clips were collected from all animals and preserved for later analysis to build a genetic library. All three tanks have been introduced to a temperature and photoperiod cycle expected to induce reproductive maturation and result in volitional spawning within approximately 150 days. Spawns collected will be assessed for fecundity and fertility, and appropriate quality spawns will be allowed to hatch for rearing at the TCMAC/USM following protocols for intensive larviculture.

Table 1: Weight, length and identifying information of Red drum broodfish transferred from the quarantine area to the reproductive maturation systems.

Tag #	Sex	Weight (kg)	Length (cm)	Destination & Comments
8678	F	6.65	87.6	no sperm, eggs, VC Tank 6
8828	M	6.95	90.1	sperm, RSGO Tank 7
8582	U	8.20	95.8	no egg, no sperm, RSGO tank 7
8869	M	7.95	91.0	sperm, VC Tank 5
8440	?F	7.40	92.5	no sperm, maybe eggs, VC Tank 6
8551	F	7.65	93.2	eggs VC Tank 5
8834	M	7.35	92.1	sperm VC Tank 6
8601	?F	8.40	91.5	no sperm, no eggs, VC Tank 5
8426	?F	8.05	93.5	no sperm, possible eggs, RSGO Tank 7
8397	?M	7.55	85.0	no eggs, possible sperm RSGO tank 7
8587	?F	6.95	91.5	no eggs, no sperm VC Tank 6
8567	M	6.20	85.1	sperm VC Tank 6
8558	?F	7.00	95.0	no sperm, no eggs, VC Tank 5
8461	U	7.10	92.0	no sperm, no eggs RSGO Tank 7
8503	U	8.15	91.7	no sperm, no eggs RSGO Tank 7
8854	M	8.50	95.5	sperm Tank 5
8432	U	10.45	99.5	no sperm, no eggs RSGO Tank 7
Average		**7.68**	**91.92**	

VC- Visitor’s center building, RSGO- Red Snapper Growout Building

Figure 1: Satellite imagery of the collection location proximity to the proposed growout site

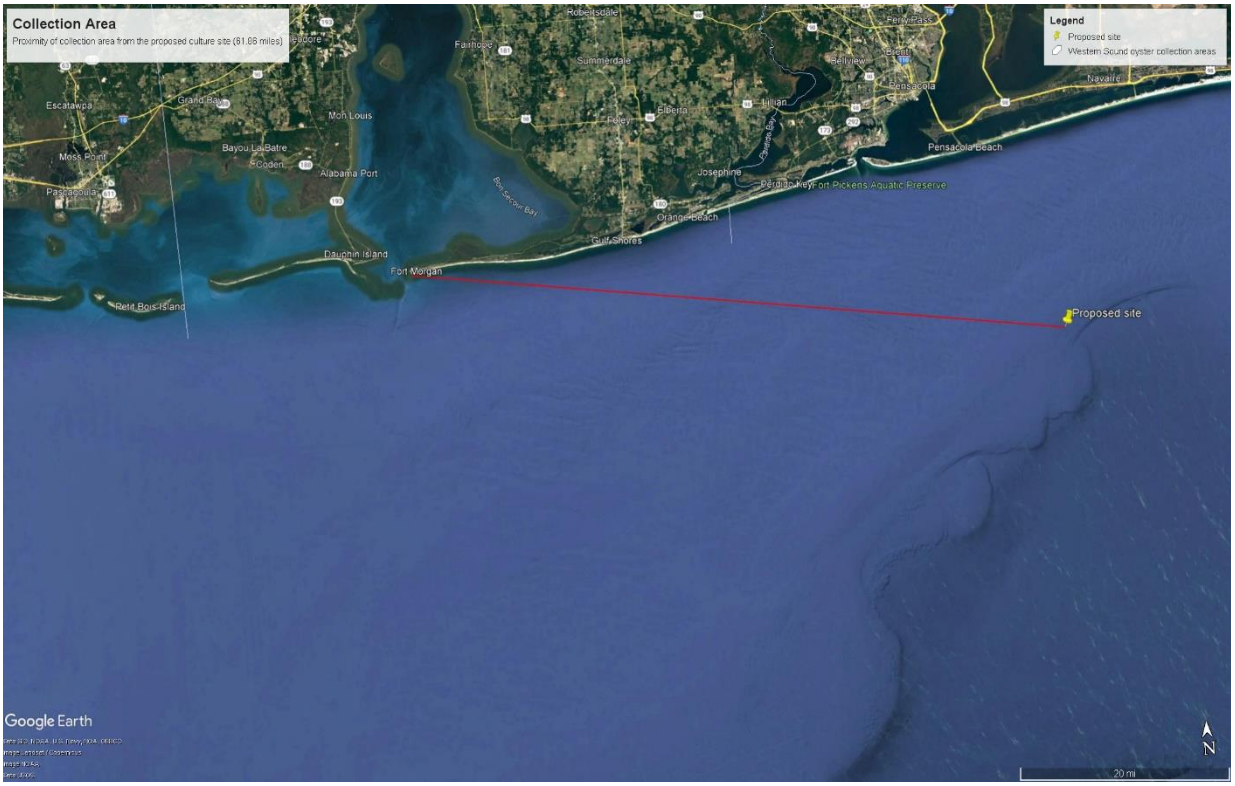
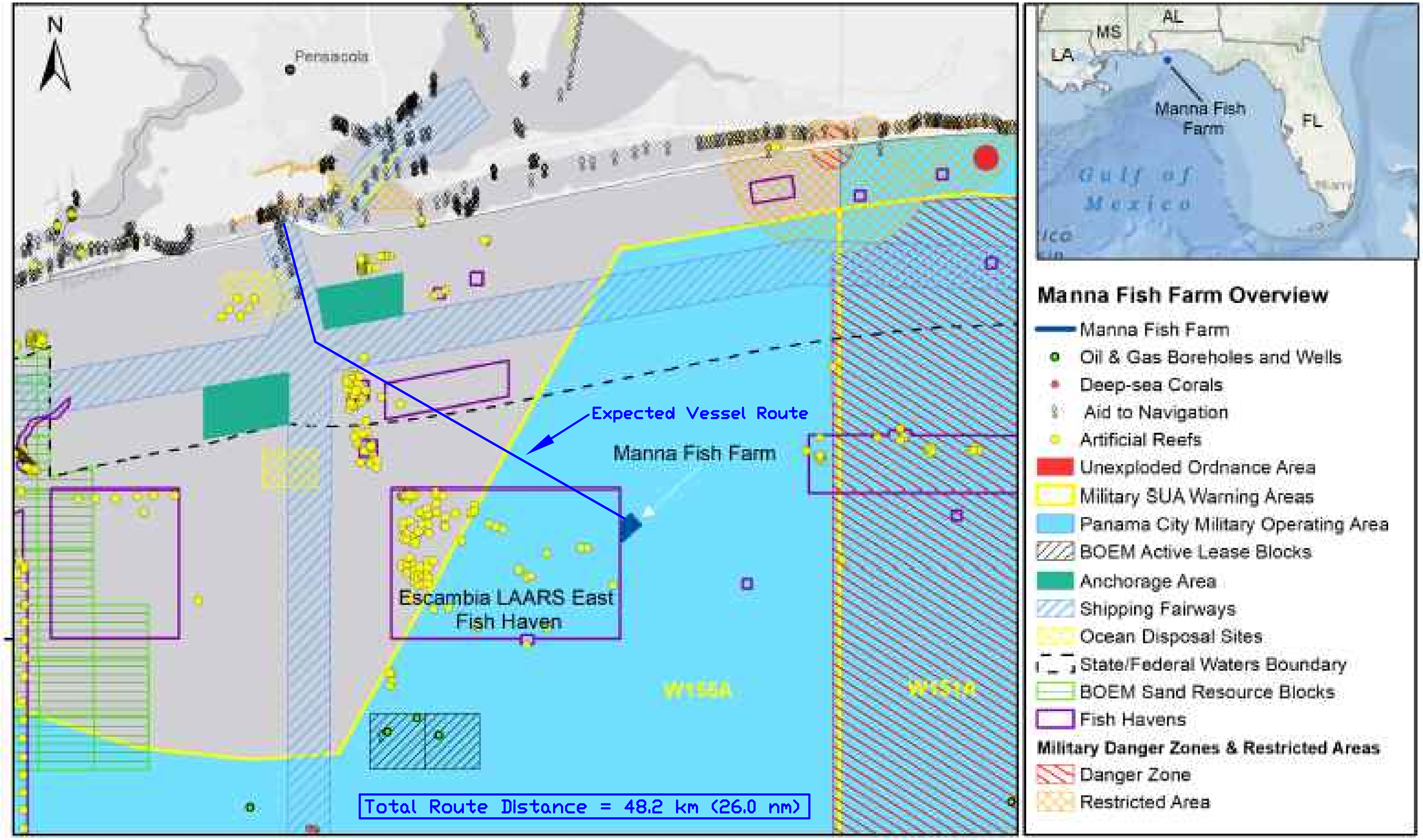


Figure 2: satellite imagery of the collection area

Appendix N:

Expected Vessel Route

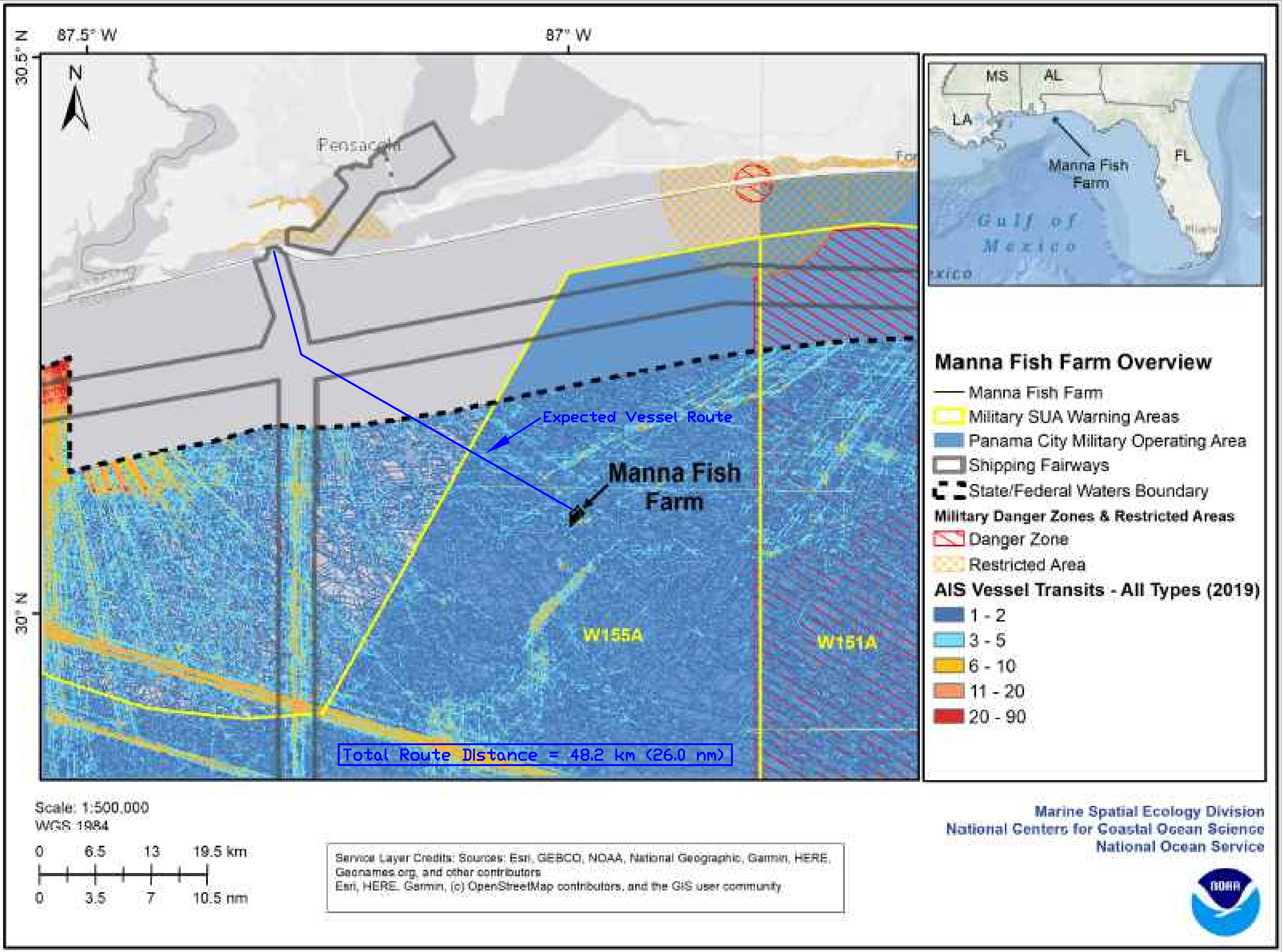


Scale: 1:500,000
WGS 1984

0 6.5 13 19.5 km
0 3.5 7 10.5 nm

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

Marine Spatial Ecology Division
National Centers for Coastal Ocean Science
National Ocean Service



87.5° W
87° W
30.5° N
30° N
N
Pensacola
Expected Vessel Route
Manna Fish Farm
W155A
W151A
Total Route Distance = 48.2 km (26.0 nm)
MS
AL
LA
FL
Manna Fish Farm
Gulf of Mexico
Manna Fish Farm Overview
Manna Fish Farm
Military SUA Warning Areas
Panama City Military Operating Area
Shipping Fairways
State/Federal Waters Boundary
Military Danger Zones & Restricted Areas
Danger Zone
Restricted Area
AIS Vessel Transits - All Types (2019)
1 - 2
3 - 5
6 - 10
11 - 20
20 - 90
Scale: 1:500,000
WGS 1984
0 6.5 13 19.5 km
0 3.5 7 10.5 nm
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Marine Spatial Ecology Division
National Centers for Coastal Ocean Science
National Ocean Service

Appendix O:

Support Vessel Trip Estimates

Table 1: *Estimated quantity and frequency of feed resupply trips during Year 1 and Year 5 of operations.*

Feed Resupply Trips	**Year 1**		**Year 5**	
Estimated Feed Capacity of Support Vessel (MT)	**70**	**100**	**100**	**150**
Minimum # Trips per Month	2.0	1.0	15.0	10.0
Maximum # Trips per Month	9.0	6.0	22.0	15.0
Average # Trips per Month (for the year)	5.33	3.75	18.75	12.5
Minimum Frequency (Days per Month)	2.0	1.0	7.5	5.0
Maximum Frequency (Days per Month)	9.0	6.0	11.0	7.5
Average Frequency (Days per Month, for the year)	5.33	3.75	9.38	6.25

*All values are based on a 90% survival rate maximum biomass
*Years 1 is prior to feed barge and accounts for (1) support vessel having multiple responsibilities: storing feed on-site, resupplying, harvesting, stocking
*Year 5 uses (2) feed barges for a total of 900MT feed stored on-site
*Year 5 uses (2) support vessels for resupply: allows for 2 trips per day
*Year 5 values are representative of farm operation continuing beyond the initial 5-year NPDES permit
*Average trips per month for the year are calculated by taking the estimated value for each month of the year and averaging those 12 values over the course of said year
*Frequency values are calculated by dividing their respective # trips per month by the quantity of support vessels present in that year

Table 2: *Estimated quantity and frequency of harvest trips during Year 1 and Year 5 of operations.*

Harvest Trips	**Year 1**	**Year 5**
Minimum # Trips per Month (lowest harvestable biomass)	0.0	0.0
Maximum # Trips per Month (highest harvestable biomass)	12.0	24.0
Average # Trips per Month (for the year)	1.0	12.0
Minimum Frequency (Days per Month)	0.0	0.0
Maximum Frequency (Days per Month)	12.0	24.0
Average Frequency (Days per Month, for the year)	1.0	12.0

*All values are based on a 90% survival rate maximum biomass
*All values are based on an avg. harvest assumption of 20 MT / day (during harvest months) and are independent of vessel capacity and quantity
*Average trips per month for the year are calculated by taking the estimated value for each month of the year and averaging those 12 values over the course of said year
*Frequency values are equivalent to their respective # of trip values since harvest is not dependent upon vessel size and/or vessel quantity

***Table 3**: Estimated quantity and frequency of stocking trips during Year 1 and Year 5 of operations.*

Stocking Trips	**Year 1**		**Year 5**	
Estimated Capacity of Support Vessel (MT)	**70**	**100**	**100**	**150**
Minimum # Trips per Month	0.0	0.0	0.0	0.0
Maximum # Trips per Month	14.0	10.0	10.0	7.0
Average # Trips per Month (for the year)	1.17	0.83	4.58	3.58
Minimum Frequency (Days per Month)	0.0	0.0	0.0	0.0
Maximum Frequency (Days per Month)	14.0	10.0	5.0	3.5
Average Frequency (Days per Month, for the year)	1.17	0.83	2.29	1.79

*All values are based on a stocking size of 100g
*Year 1 is prior to feed barge installation and accounts for (1) support vessel having multiple responsibilities: storing feed on-site, resupplying, harvesting, stocking
*Year 5 values are representative of farm operation continuing beyond the initial 5-year NPDES permit
*All values assume only 50% of the vessel's capacity is spatially available for live transport tanks
*Year 5 uses (2) support vessels: allows for 2 trips per day
*Average trips per month for the year are calculated by taking the estimated value for each month of the year and averaging those 12 values over the course of said year
*Frequency values are calculated by dividing their respective # trips per month by the quantity of vessels present in that year

Appendix P:

NOAA Fisheries Southeast Regional Office Vessel Strike Avoidance Measures

VESSEL STRIKE AVOIDANCE MEASURES,
NOAA FISHERIES SOUTHEAST REGIONAL OFFICE

Background
Vessel strikes can injure or kill species protected under the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA). NOAA Fisheries Southeast Regional Office (SERO) Protected Resources Division (PRD) recommends implementing the following identification and avoidance measures to reduce the risk of vessel strikes and disturbance from vessels to protected species under our jurisdiction.[1]

Protected Species Sightings
All vessel operators and crews should be informed about the potential presence of species protected under the ESA and the MMPA and any critical habitat in a vessel transit area. All vessels should have personnel onboard responsible for observing for the presence of protected species. All personnel should be advised that there are civil and criminal penalties for harming, harassing, or killing listed species and all marine mammals. To determine which protected species and critical habitat may be found in the transit area, please review the relevant marine mammal and ESA-listed species at Find A Species (https://www.fisheries.noaa.gov/find-species) and any ESA Section 7 consultation documents if applicable.

Vessel Strike Avoidance
The following measures should be taken when they are consistent with safe navigation to avoid causing injury or death of a protected species:

1. Operate at the minimum safe speed when transiting and maintain a vigilant watch for protected species to avoid striking them. Even with a vigilant watch, most marine protected species are extremely difficult to see from a boat or ship, and you cannot rely on detecting them visually and then taking evasive action. The most effective way to avoid vessel strikes is to travel at a slow, safe speed. Whenever possible, assign a designated individual to observe for protected species and limit vessel operation to only daylight hours.

2. Follow deep-water routes (e.g., marked channels) whenever possible.

3. Operate at “Idle/No Wake” speeds in the following circumstances:
    a. while in any project construction areas
    b. while in water depths where the draft of the vessel provides less than four feet of clearance from the bottom, or
    c. in all depths after a protected species has been observed in and has recently departed the area.

[1] Manatees are managed under the jurisdiction of the U.S. Fish and Wildlife Service.

4. When a protected species is sighted, attempt to maintain a distance of 150 feet or greater between the animal and the vessel. Reduce speed and avoid abrupt changes in direction until the animal(s) has left the area.

5. When dolphins are bow- or wake-riding, maintain course and speed as long as it is safe to do so or until the animal(s) leave the vicinity of the vessel.

6. If a whale is sighted in the vessel's path or within 300 feet from the vessel, reduce speed and shift the engine to neutral. Do not engage the engines until the animals are clear of the area. *Please see below for additional requirements for North Atlantic right whales.*

7. If a whale is sighted farther than 300 feet from the vessel, maintain a distance of 300 feet or greater between the whale and the vessel and reduce speed to 10 knots or less. *Please see below for additional requirements for North Atlantic right whales.*

Injured or Dead Protected Species Reporting
Vessel crews should report sightings of any injured or dead protected species immediately regardless of whether the injury or death is caused by your vessel. Please see How to Report a Stranded or Injured Marine Animal (https://www.fisheries.noaa.gov/report) for the most up to date information for reporting injured or dead protected species.

If the injury or death is caused by your vessel, also report the interaction to NOAA Fisheries SERO PRD at takereport.nmfsser@noaa.gov. Please include the species involved, the circumstances of the interaction, the fate and disposition of the animal involved, photos (if available), and contact information for the person who can provide additional details if requested. Please include the project's Environmental Consultation Organizer (ECO) number and project title in the subject line of email reports if a consultation has been completed.

Reporting Violations
To report any suspected ESA or MMPA violation, call the NOAA Fisheries Enforcement Hotline. This hotline is available 24 hours a day, 7 days week for anyone in the United States.

NOAA Fisheries Enforcement Hotline: (800) 853-1964

Additional Transit and Reporting Requirements for North Atlantic Right Whales

1. Federal regulation prohibits approaching or remaining within 500 yards of a North Atlantic right whale (50 CFR 224.103 (c)). All whales sighted within North Atlantic right whale critical habitat should be assumed to be right whales. Please be aware and follow restrictions for all Seasonal Management Areas along the U.S. east coast. These areas have vessel speed restrictions to reduce vessel strikes risks to migrating or feeding whales. More information can be found at Reducing Vessel Strikes to North Atlantic Right Whales (https://www.fisheries.noaa.gov/national/endangered-species-conservation/reducing-vessel-strikes-north-atlantic-right-whales).

2. Ships greater than 300 gross tons entering the WHALESOUTH reporting area are required to report to a shore-based station. For more information on reporting procedures consult 33 CFR Part 169, the Coast Pilot, or at Reducing Vessel Strikes to North Atlantic

Right Whales (https://www.fisheries.noaa.gov/national/endangered-species-conservation/reducing-vessel-strikes-north-atlantic-right-whales).

3. From November through April, vessels approaching/departing Florida ports of Jacksonville and Fernandina Beach as well as Brunswick Harbor, Georgia are STRONGLY RECOMMENDED to use Two-Way Routes displayed on nautical charts. More information on Compliance with the Right Whale Ship Strike Reduction Rule can be found at (https://media.fisheries.noaa.gov/2021-06/compliance_guide_for_right_whale_ship_strike_reduction.pdf)

4. Mariners shall check with various communication media for general information regarding avoiding vessel strikes and specific information regarding North Atlantic right whale sighting locations. These include NOAA weather radio, U.S. Coast Guard Broadcast to Mariners, Local Notice to Mariners, and NAVTEX. Commercial mariners calling on United States ports should view the most recent version of the NOAA/USCG produced training CD entitled “A Prudent Mariner’s Guide to Right Whale Protection” (contact the NOAA Fisheries SERO, Protected Resources Division for more information regarding the CD).

5. Injured, dead, or entangled right whales should be immediately reported to the U.S. Coast Guard via VHF Channel 16 and the NOAA Fisheries Southeast Marine Mammal Stranding Hotline at (877) WHALE HELP (877-942-5343).

For additional information, please contact NOAA Fisheries SERO PRD at:
NOAA Fisheries Service
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701
Visit us on the web at Protected Marine Life in the Southeast
(https://www.fisheries.noaa.gov/region/southeast#protected-marine-life)

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